PHYSICAL SOCIETY EXHIBITION PREVIEW—*Pages 27 to 38*

LABORATORY PRACTICE

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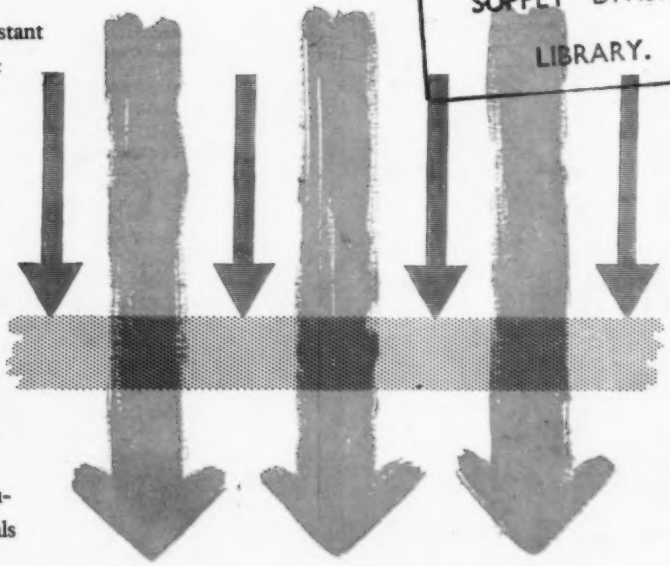
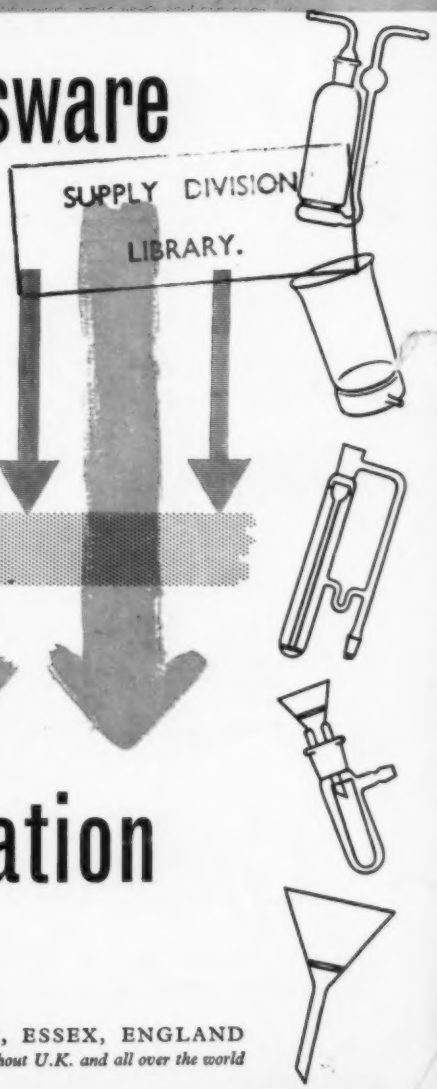
RESEARCH · CONTROL · TEACHING
VOL. 8 No. 1 Published Monthly JANUARY 1959

B.T.L. Sintered Glassware





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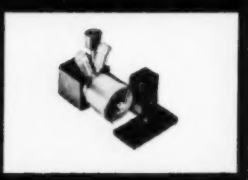

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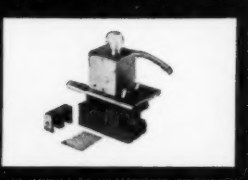

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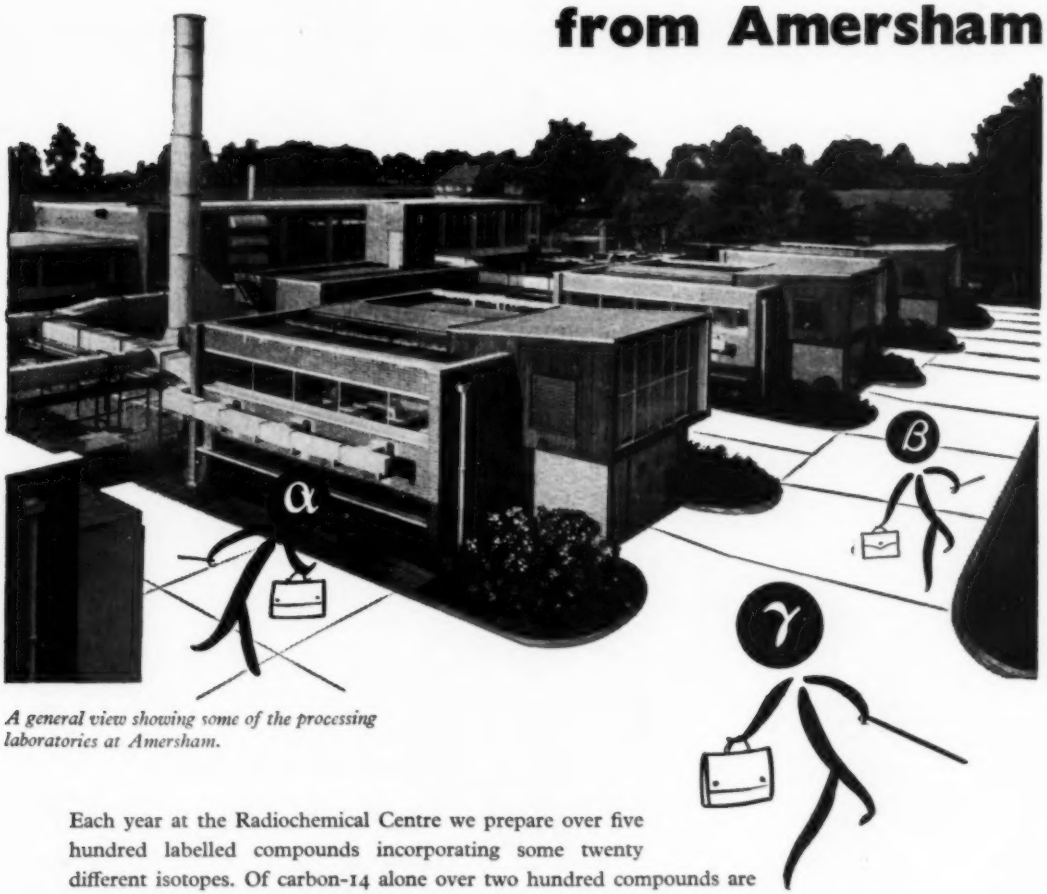

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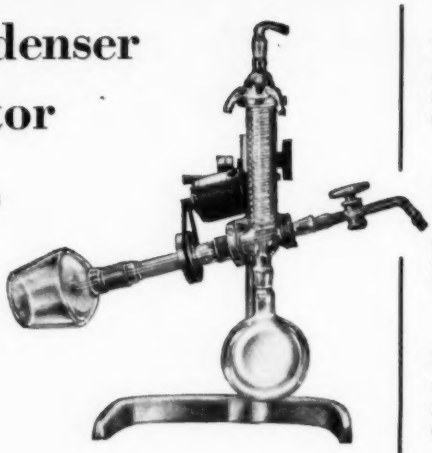

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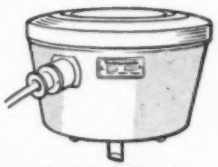

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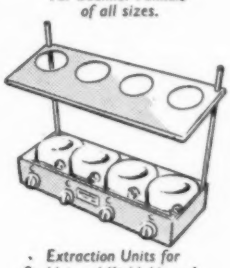

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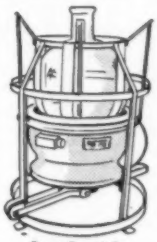

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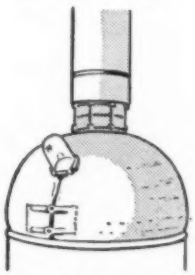

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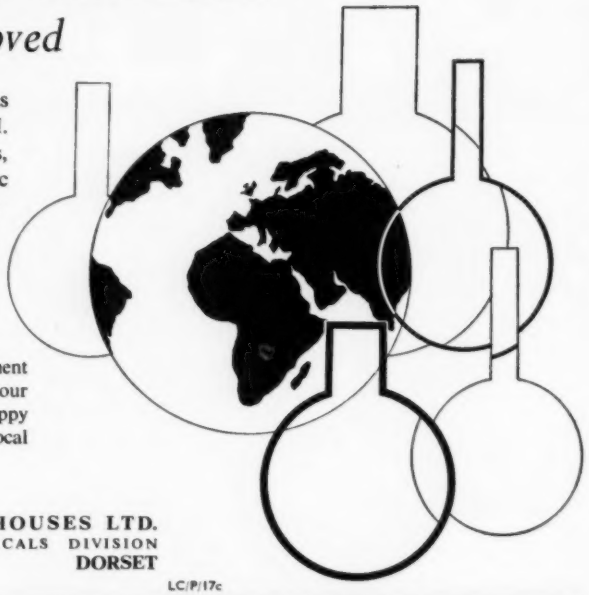

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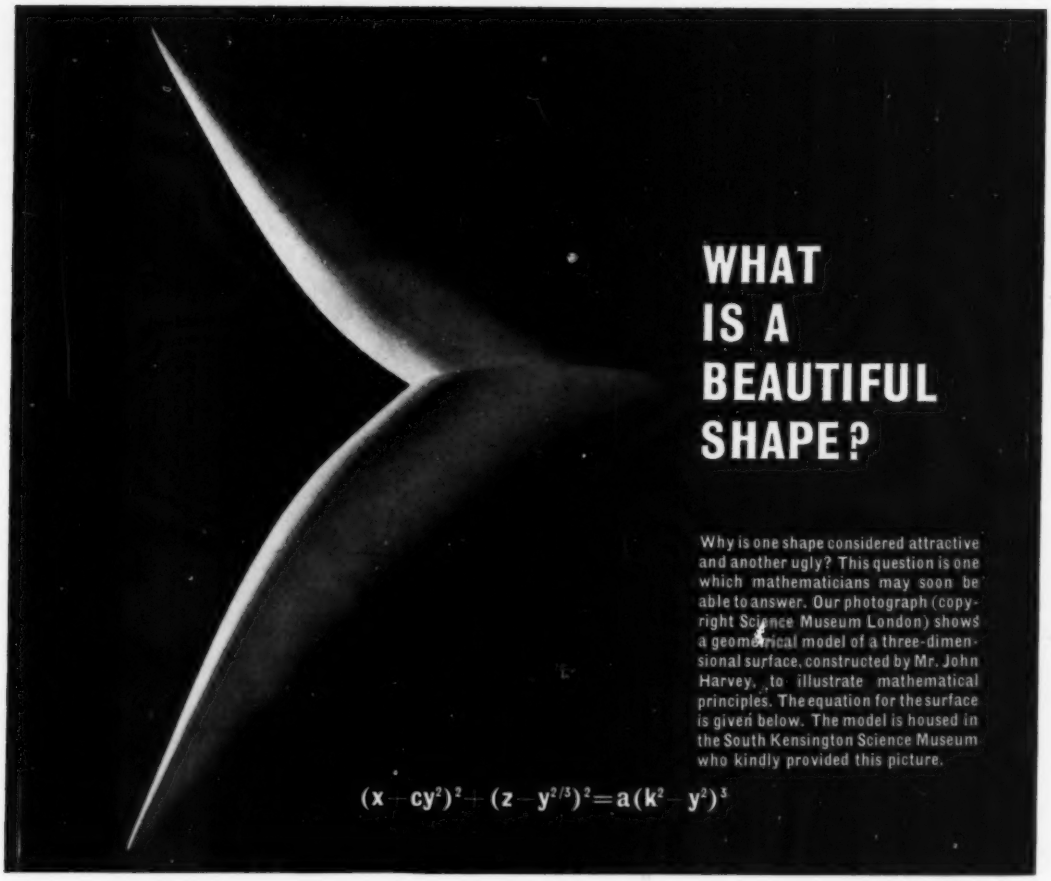

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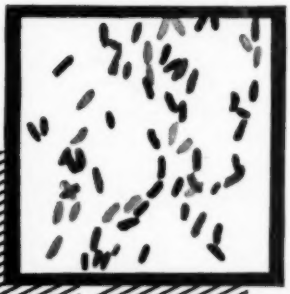

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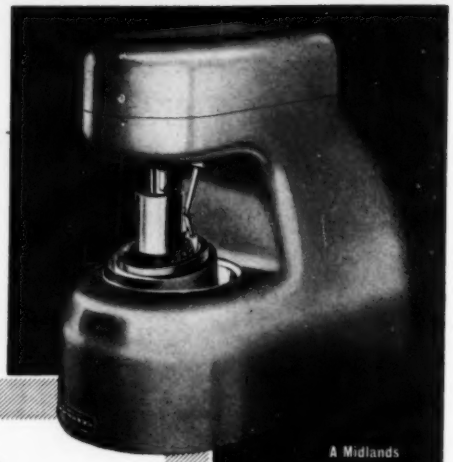

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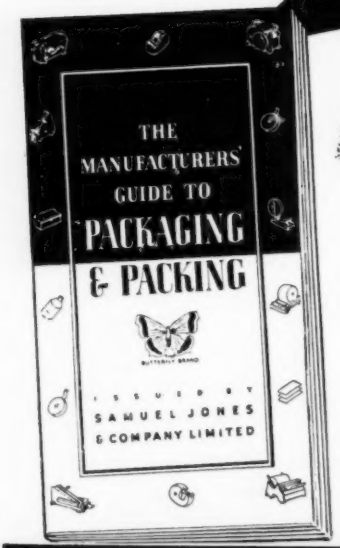

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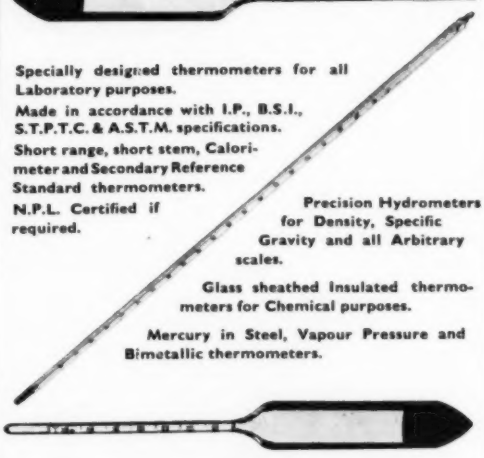

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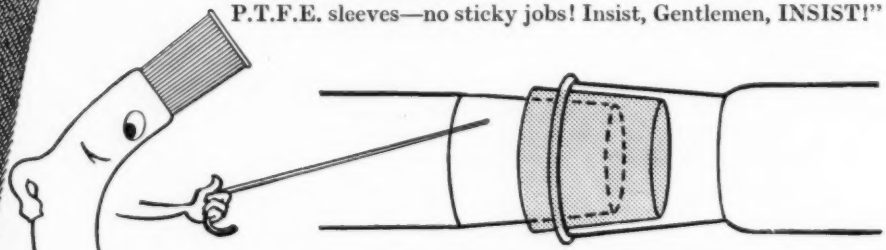

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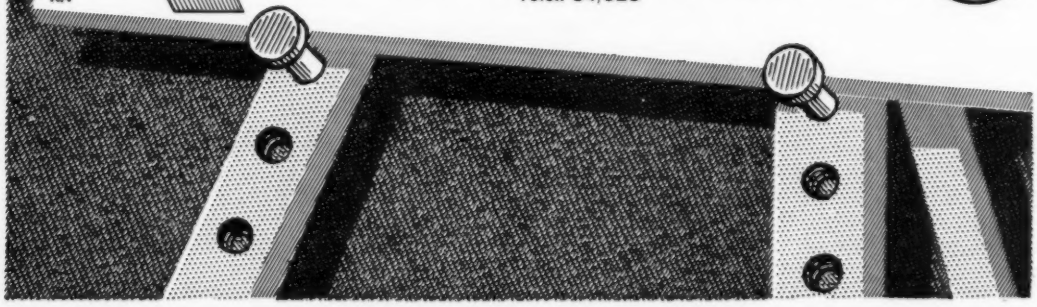

LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

Vol. 8 JANUARY 1959 No. 1

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EDITORIAL

University Entrance and Compulsory Subjects

A HARDY old dragon has reared its head again recently. Should Latin be a compulsory subject for entrance to a university? The diehards in this matter have been the universities of Oxford and Cambridge and now, ten years after an unsuccessful attempt to do away with compulsory Latin at Cambridge, the subject is to be debated next term.

The reasons why Latin has for so long been a compulsory subject are well recognized, and the justification for keeping it so in the past is often accepted by those who today urge that the time has come for a rethinking on the matter. In the days when Latin was the universal language of educated people in all countries in Europe, and even scientific books were published in Latin, the case for Latin as a compulsory subject was unanswerable.

Moreover the curriculum of any educational establishment was fairly limited in those days, and, apart from mathematics for the special students of this subject, Latin might well be regarded as the only subject whose study would confer training in logical thought, the study and expression of ideas in a clear, unambiguous way, a mental discipline in learning the grammar of one of the great languages of the world, as well as permitting gentlemen from various countries to converse together with ease. Indeed even today we hear of examples of scientists from some countries falling back upon Latin as the best language for communication when both are unable to speak English, French or German. In those days every gentleman and every lady was expected to know Latin. It was as much a hallmark of education then as a matriculation or G.C.E. certificate is now.

Whatever justification there has been for compulsory Latin in the past, there is little today. Not only is our educational programme completely different, but the whole pattern of university life and study is altered. Gone are the days when three years at a university formed a convenient period for a young gentleman to sow his wild oats, and entrance was limited almost entirely to those who could afford to pay the fees themselves.

Any question about methods of admitting students to a university must inevitably be bound up with our conception of the function of a university. The senior officials of our universities and colleges may impress us by their use of high-sounding phrases when discussing this subject, but these on analysis may prove to be obvious to all or quite meaningless. For example, it may be impressive to say that a university education prepares one for life in the fullest meaning of the word, but is a university the best place for this, and are the typical members of a university staff the best people to prepare young men and women for life? We think not. The best way to prepare for life, in fact the only way, is to experience it as fully as possible, a thing that few members of a university staff ever do. Left to themselves outside the shelter of the academic cloister, some would be hopeless misfits in the outside world.

Let us be quite frank about the function of a university or college today. It gives an entrance to a profession which, in the absence of a university education, would be impossible or extremely difficult. The tremendous increase in the importance of science since the war, the forward educational policy of the country, and the plentiful grants from the state and local authorities have all combined to increase the competition for university places. There may be up to five candidates for every place, and those who cannot stay the course are weeded out without fear or favour. The avowed policy of all our universities is first and foremost to turn out the best graduates possible. Although in the field of knowledge science has no special standing, practical politics today calls on our universities to step up the output of science graduates.

The method of selecting university entrants, like the method of educating them when they are safely in, must always be a compromise. The increasing importance of the 'Honours' course inevitably favours specialization at the expense of education and culture in the broadest sense. What does the outside world, and especially the employer, expect from the graduate?

It is possible for a man to have a profound knowledge of Greek participles, the life history of some insect in Brazil or of some esoteric branch of mathematics, but to be amazingly ignorant of the world in general. Does such a man justify a claim to be a university graduate or an educated man? There is much to be said for the old definition which says that an educated man knows everything about something, and something about everything.

Latin as a compulsory subject has in the past effectively prevented many able men from entering a particular university, and many of those passing have merely crammed it for the occasion and forgotten it immediately afterwards. Can this be regarded as having educational value? Shakespeare had 'little Latin and no Greek' and there have doubtless been hundreds of great writers and thinkers in the arts who could never pass an examination in Latin. If there must be a compulsory subject today good cases could be made for many subjects—mathematics, philosophy, psychology, history, English, a modern language, general science and even 'general knowledge'.

Genius knows no rules, and is best left to work out its own salvation. A genius may fail to gain admission to a university which insists on compulsory subjects, but a genius will always succeed. The danger lies in the rejection of the clever, for whom failure in university entrance may mean a frustrated life. For the assessment of these there is the school record which, quite apart from the question of a compulsory subject, is a much better basis for selection for a university place than any one examination.

R.I.C. Annual General Meeting

The Annual General Meeting of the London Section of the Royal Institute of Chemistry was held at the Royal Society of Health, Buckingham Palace Road, S.W.1, on November 19 when the Section Chairman, Dr. C. C. Hall presided and the following Officers were elected:

Chairman, Mr. F. C. Hymas;
Vice-Chairman, Mr. P. A. Raine;
Hon. Treasurer, Mr. P. F. Corbett.

The following remained in office:
Vice-Chairman, Dr. J. H. Pryor;
Hon. Sec., Dr. S. A. Miller;
Hon. Asst. Sec., Mr. G. C. Ackroyd.

The Chairman announced that the following nominations had been received for the seven vacancies which existed on the Committee: Messrs. R. J. Cole, T. Dewing, W. C. A. Hards, F. L. Hulbert, G. H. Jeffery and N. Lindop. The Committee nominated Dr. C. Simons to fill the remaining vacancy and the Chairman declared these seven gentlemen elected to serve for a period of three years. Dr. H. G. Smith and Mr. A. H. Thorneloe were elected Hon. Auditors and Mr. D. M. Freeland, Hon. Almoner.

Mr. Freeland gave an outline of the work of the Benevolent Fund during the past year mentioning certain bequests and additions to their resources during the year. He drew attention to the valuable aid provided by the fund and urged members to continue their support.

Dr. J. H. Pryor paid tribute to the work of all retiring officers and members of the Committee. In particular he thanked the retiring Chairman, Dr. C. C. Hall for his untiring efforts and able guidance over the past years.

The business meeting was followed by an informal discussion on Institute affairs. It was opened by Dr. Hall who said that it provided an admirable opportunity to correct some misconceptions which undoubtedly existed concerning Council. He then proceeded to give a survey of the work of Council, quoting several examples where prompt action had followed suggestions made by Local Sections. In the ensuring hour an extended and vigorous discussion took place in which many members expressed their views on Institute policy and activities. Criticism was deliberately encouraged, needless to say this was forthcoming but many members also expressed appreciation of the Institute's work. The subjects covered included Regulations for Admission, Examinations, provision of films on chemistry, facilities for teaching and many others. Attention was drawn to the difficulties often experienced by older chemists in finding suitable employment and there were many comments on the recent measure by which certain Professional Subscriptions became eligible for relief from Income Tax.

ORIGINAL CONTRIBUTION

THE TOXIC HAZARD ASSOCIATED WITH CONTINUOUS-FLOW HEAT-VOLATILIZED INSECTICIDAL AND ACARICIDAL AEROSOLS

by A. Howard Baker and G. F. H. Whitney

Avebury Research Laboratories, Goring-on-Thames

and Alastair N. Worden

Nutritional Research Unit, Huntingdon

Summary

Small mammals, birds and laboratory workers were exposed to the output of continuously operated pesticide vaporizers volatilizing aldrin or azoxybenzene or one of three dose levels of a mixture of lindane with D.D.T. Exposures lasted for periods varying between 178 and 386 days. The toxicity to house flies of residual deposits produced in the experimental rooms was tested and chemical analysis of affected animals was carried out. A direct relationship was found between dose level and insect response to surface deposits. Horizontal plates acquired a more effective deposit than vertical ones. Mouse fur was practically free from deposited lindane but the feathers of budgerigars readily accumulated a considerable amount. Output characteristics of the pesticides are discussed.

Budgerigars were unable to survive at the highest dose of the lindane/D.D.T. mixture which had a mean value of 0·754 *g.d.t. (g./day/1,000 cu. ft.). At the lower dose levels of the mixture* (0·531 *and* 0·224 *g.d.t.) and at doses of* 0·500 *g.d.t. of aldrin and* 0·429 *g.d.t. of azoxybenzene no deleterious effects were observed. In addition to the birds and mice other animals exposed to one or more of the treatments were: rats, dogs, guinea pigs, golden hamsters and human subjects; in no case did they suffer any detectable harm.*

Introduction

The object of the investigation described below was to determine the degree of hazard which might arise in certain mammals and birds from continuous exposure to aerosols and the attendant vapours of a mixture of D.D.T. and lindane, of aldrin, and of azoxybenzene in concentrations adequate for the control of house flies, other flying insects, the ectoparasites of domestic and laboratory animals, and plants.

The first published reference to continuous-flow, heat-volatilized insecticidal aerosols was that of Stammers and Whitfield (1947), who recorded the safe use of 2, 2-bis-(p-chlorophenyl)-1, 1, 1-trichlorethane (D.D.T. or dicophane) by this means. Thermally generated aerosols liberating D.D.T. and the gamma isomer of 1, 2, 3, 4, 5, 6-hexachlorocyclohexane (lindane), either alone or mixed together, have since been widely used on a practical scale in Great Britain, U.S.A. and other countries, without any valid evidence of toxic effect upon man, domestic mammals or poultry (Whitfield, Baker and Whitney, 1952; Whitfield, 1953). There seemed nevertheless, to be a need for more precise information upon the susceptibility of different species to D.D.T., lindane and also to the insecticide 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 4, 8, 8a-hexahydro-1, 4-*endo exo*-5, 8-dimethanonaphthalene (aldrin) and to the acaricide, azoxybenzene, any of which may be employed with this type of generator. The present series of experiments was devised accordingly.

In their original trials Stammers and Whitfield (1947) exposed laboratory workers for five hours daily on five consecutive days, and rats, guinea pigs and rabbits continuously for 28 days, to D.D.T. without any evidence of harm. Lehmann (1949) and Haller (1951) have similarly referred to D.D.T., while Munch, Sloan and Latven (1948), Spears (1952), and Hensill and Leland (1952) have all indicated that the mammalian toxicity of vaporized lindane is of a low order. These findings have been reviewed by Whitfield (1953).

There seems to be no published reference to the chronic toxicity of atmospheric aldrin previous to that of Princi (1951), who studied 34 workers who had been exposed to the danger of inhaling dust and vapour during the manufacture of aldrin and dieldrin. The factory atmosphere was found to contain more than 5 mg. per m^3 (142 mg./1,000 $ft.^3$) of these two compounds, and individuals were exposed during normal working hours for periods of one to three years. 'There was no evidence however, of any deleterious effects on the central nervous system, the liver, the kidneys or the hemopoietic system'.

There is similarly no recorded information on azoxybenzene aerosols. Azoxybenzene, which is regarded as having a toxicity of the same order as azobenzene (Spector, 1956), is used mainly against mite pests of plants, and its use under glass might therefore constitute a risk to horticultural workers.

Materials

The pesticides in the following experiments were of a grade suitable for commercial service in vaporizer units. D.D.T. was technical material conforming to the W.H.O specification (1956); azoxybenzene was also the technical grade product of good quality, melting at 36°C.; lindane was the commercially available 99 per cent gamma isomer melting at 112·5°C. Technical grade aldrin is not suitable for general vaporizer practice on account of the marked, objectionable odour which becomes evident when the substance is first heated and persists for several days afterwards. This material was therefore deodorized by refluxing with one-tenth its weight of activated carbon in about five parts of ethanol for an hour, filtering hot, cooling and filtering off the crystals with suction. The dried product melts at 100-102°C., and is assumed to be practically pure 'H.H.D.N.' the constituent which forms approximately 85 per cent of technical aldrin.

Initially the lindane/D.D.T. mixture consisted of 60 per cent lindane and 40 per cent D.D.T. but the fractionation which occurred during the heating period because of the greater volatility of the lindane caused a gradual decrease in the proportion of lindane in the insecticide remaining in the vaporizer unit and a falling off of output rate as indicated hereunder.

Output Characteristics of the Binary Mixture

When a pure substance is dispensed by the vaporizer unit from the liquid state it is convenient to derive the output rate from the Clausius-Clapeyron equation:

$$\log r = a - \frac{b}{T}$$

where r=output rate (gram per day), T=absolute temperature (°K), and a and b are constants peculiar to the working substance.

If the values of r for lindane and D.D.T. are denoted by L and D respectively it has been found that:

$\log_{10} L = 11{\cdot}6657 - 4402/T$ and

$\log_{10} D = 13{\cdot}1028 - 5509/T$.

(It should be noted that these values for a and b would generally alter if the design or dimensions of the unit were changed).

In the case of binary mixtures of lindane and D.D.T. it has been found that the partial output rate of either component is directly and linearly related to the proportion of that component present in the mixture. Hence it has been deduced theoretically that:

$$x/L + y/D + t = C \ldots\ldots \text{(i)}$$

where x=weight of lindane in the unit (g.), y=weight of D.D.T. in the unit (g.), t=time of heating (days), c=a constant which is the sum of the heating times required completely to volatilize the respective quantities of the two components when heated alone at the temperature in question. At the beginning of the heating period t=O and the amounts of the constituents are known, i.e. $x=x_o$ and $y=y_o$ whence $C=x_o/L + y_o/D$. Also it may be shown that:

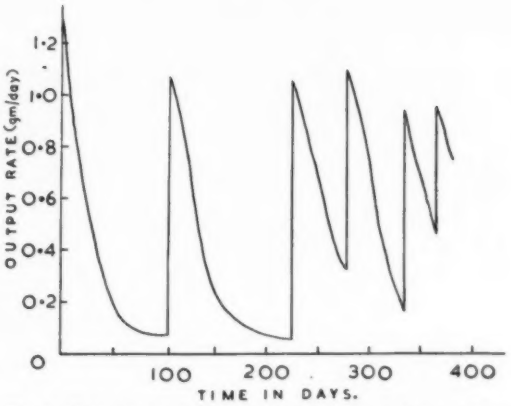

Fig. 1. Output rate of D.D.T./ lindane mixture in room PM. Each peak corresponds with the introduction of a fresh cup of insecticide.

$$(y/y_o)^L = (x/x_o)^D \ldots\ldots \text{(ii)}$$

from which y may be calculated for any given value of x.

Thus if a series of values of x are chosen and the corresponding values of y obtained from (ii) it becomes possible to find the corresponding values of t from equation (i). If the total weight of mixture remaining be denoted by m=x + y the graph of m against t may readily be constructed and compared with the analogous curve obtained from experimental measurements. By this means it has been found that the predictions of the theoretical equations are closely followed in practice. The output rate for the mixture is:

$$\frac{dm}{dt} = \frac{Lx + Dy}{m}$$

and for each cup of insecticide the output rate, which initially is at its maximum, gradually falls off and tails away asymptotically towards the level of output of D.D.T. alone, later dropping more or less rapidly to zero according to the amount of non-volatile impurities remaining in the residue. When a fresh cup is inserted the same process is repeated so that the graph of output rate against time for an experiment of long duration has a saw-toothed appearance (Fig. 1).

Output Characteristics of the Single Substances

Aldrin and azoxybenzene heated alone at constant temperature resemble other single substances in that their output rates remain constant or very nearly so until the contents of the units are completely vaporized. If small amounts of impurity are present those having a higher volatility add an initial peak to the output rate while those with a lower volatility cause the output rate to tail off gradually at the end of the life of the cup instead of falling suddenly from the normal level down to zero. For the present purpose the output of the single substance is taken to be constant at any fixed temperature.

If A and Z are respectively the output rates of aldrin

TABLE I

Room	Volume (cu. ft.)	Material	Dose (g.d.t.)		Exposure Period (days)
			Initial	Mean	
L	1530	Azoxybenzene	—	0·429	242
M	1670	Aldrin	—	0·500	178
PM	590	D.D.T./Lindane	1·570	0·754	381
R	720	D.D.T./Lindane	0·668	0·531	386
S	3300	D.D.T./Lindane	0·513	0·224	386

g.d.t. = g./day/1,000 cu. ft.

TABLE II
Animals Housed in Test Rooms

Room	Species	Description	Sex	Number
L	Budgerigars	Commercial	M, F	2
	Budgerigars	Commercial, progency	M, F	3
	Mice	Chester Beatty C_3H	F	4
	Golden hamsters	M.R.C. stock	M	8
	Guinea pigs	M.R.C. stock	M	8
M	Budgerigars	As in room L	M, F	2
	Mice	As in room L	F	4
	Golden hamsters	As in room L	M	8
	Guinea pigs	As in room L	M	8
	Dog	Scottish terrier	M	1
PM	Budgerigars	As in room L	M, F	12
	Mice	As in room L	M, F	4
R	Budgerigars	As in room L	M, F	2
	Rats	Hooded Lister Stock	M, F	72
	Rats	Hooded Lister Stock progency	M, F	720
	Mice	Chester Beatty C_3H	F	2
	Mice	Commercial mousery stock	M, F	24
	Mice	Commercial mousery stock progency	M, F	148
S	Budgerigars	As in room L	M, F	2
	Dogs	Golden retriever	M	2
	Dog	Husky	M	1
	Dog	Scottish terrier	M	1
	Dogs	Crossbred	F	3

and azoxybenzene in grams per day, the operating temperature being, as before, T °K then:

$\log_{10} A = 12{\cdot}8812 - 4914/T$ and

$\log_{10} Z = 7{\cdot}4967 - 2863/T$.

Methods

(*a*) *Exposure of Experimental Mammals and Birds.*—Each of five rooms (all housing experimental animals and all used during working hours by laboratory staff) was fitted with a standard commercial volatilizing unit. Five different treatments were administered involving three dose levels of a mixture of lindane and D.D.T., one level of aldrin and one of azoxybenzene. Units operated continuously throughout the experimental periods during which the cups were weighed and temperatures checked twice weekly. Details of the rooms and their associated treatments are given in Table I. Particulars of the animals housed in the five rooms are given in Table II.

Although the exposure of animals formally terminated

on December 31, 1957, the weighing of cups and checking of unit temperatures being discontinued from that date, the units were allowed to remain in operation as before; two budgerigars were introduced on January 2, 1958, and, as mentioned below (Table V) four budgerigars died during January, 1958.

The rooms were at the normal ambient temperature with the exception of Room L which was thermostatically controlled at 15·5°C. and Room R which was maintained at 18-21°C.

(*b*) *Chemical Analysis.*—Animals that died during the experimental period were subjected to *post-mortem* examination, and, where non-specific causes could not be excluded, the tissues were examined chemically. The only such deaths occurred in the room receiving the highest dose of lindane/D.D.T. mixture, and the chemical examination was confined to that for lindane.

Samples of the appropriate tissues were—except for budgerigar skin and feathers—ground with sand. Petroleum ether (40°-60°C.) was stirred in and the mixture allowed to stand overnight at room temperature in a stoppered flask. Aliquots of the filtered petroleum ether extract were evaporated down and the lindane estimated by the aniline method of Phillips (1952), involving measurement of the violet colour obtained with an absorption maximum at 510 mμ in a Spekker photoelectric absorptiometer using a Kodak No. 522 green filter.

In addition to the standard calibration curve previously derived from known concentrations of lindane in petroleum ether solutions, two sets of controls were used as a check on the effect of introducing animal tissues into the analytical process. Two untreated budgerigars and one untreated mouse were analysed together with a similar number of these animals the tissues of which were fortified by the addition of known amounts of lindane in ethanol immediately after dissection. The 'untreated tissue blank' was obtained from the first set of controls which showed no significant variation ascribable to differences between tissues or between animals. Hence the mean value for these controls, namely 18 μg. per g., was subtracted from the figures for the treated and the fortified groups as a correction for the effect of the tissues, which appeared to give rise to a little suspended matter. The 'fortified tissue' controls gave an estimate of the percentage recovery of lindane which had a mean value of 70·7 per cent. Analysis of variance showed that no significant differences were demonstrable between tissues or between animals and consequently the results for the treated animals were corrected for 'percentage recovery' by multiplying them by 100/70·7.

(*c*) *Exposure of Laboratory Workers.*—The laboratory personnel entered the treated rooms in the ordinary course of their work, the amount of time spent by each person in each room being noted in Table III.

As there is no history of previous exposure to insecticides or to the atmosphere of chemical laboratories or factories, the subjects participating in the tests are no more likely to have developed tolerance to the pesticides than other members of the general public.

(*d*) *Exposure of Houseflies.*—The toxicity of the residual deposit produced by the treatments was tested in the case of aldrin and the D.D.T./lindane mixture by confining house flies on the surface of four-inch-square plates which had been exposed in the test rooms for the

TABLE III
Hours of Exposure of Laboratory Workers

Room	*Subject*	*Age*	*Sex*	*Weight (kg)*	*Total hours exposed*
L	J.S.L.	24	M	87·7	1120
	S.G.S.	19	M	63·1	1264
	B.P.W.	20	F	55·9	830
M	J.A.F.	19	F	53·9	214
	R.S.	16	M	69·6	92
	C.R.	16	M	70·2	84
PM	A.T.	23	F	55·9	206
	A.C.	18	F	56·3	160
	J.A.F.	19	F	53·9	98
R	A.T.	23	F	55·9	824
	A.C.	18	F	56·3	230
	G.M.W.	21	M	71·6	164
	S.A.D.M.	32	M	91·0	220
S	J.A.F.	19	F	53·9	620
	R.S.	16	M	69·6	220
	C.R.	16	M	70·2	94

TABLE IV
Animal Records in Test Rooms

Room	*Species*	*Results*
L	Budgerigars	Normal; pair bred successfully.
	Mice	Normal
	Golden hamsters	Normal
	Guinea pigs	Normal
M	Budgerigars	Normal
	Mice	Normal
	Golden hamsters	Normal
	Guinea pigs	Normal
	Dog	Normal; exposed for total of 30 days.
PM	Budgerigars	All died; *see* Table V.
	Mice	Normal; except for single death.
R	Budgerigars	Normal; removed after 100 days.
	Rats	Normal; bred freely according to plan.
	Mice	Normal; bred freely according to plan.
S	Budgerigars	Normal
	Dogs	Normal; these animals were out of the room in their runs for 4-6 hours daily in fine weather.

duration of the experiments. Four types of material were chosen, namely, glass, asbestos cement sheet, fibre board and wood, one square of each material being placed horizontally and one vertically in each test room. The plates were removed at intervals of about three months and returned after the few hours necessary for completion of the fly tests. The insects were confined on the treated surfaces in batches of ten within a clear plastic ring covered with a glass plate, the exposure times being one minute or five minutes according to the responses expected. Observations of knockdown were made after one and two hours.

It was not possible to arrange suitable biological tests for the acaricide azoxybenzene.

At the end of the mammalian toxicity experiments the plates were removed to a clean atmosphere and re-tested one month and three months after the end of the experiments. The exposure times were one minute and two minutes respectively.

Results

(*a*) *Mammals and Birds.*—The only treatment which gave rise to toxic symptoms or mortality was in room PM in which the toxic effects were confined to budgerigars. The single death in a mouse was almost certainly non-specific and the other mice in this room were completely unaffected even though the room was unheated.

Tables IV and V give the detailed responses for the animals generally and for the budgerigars in room PM respectively.

(*b*) *Chemical Analysis.*—After applying the corrections for the 'untreated tissue blank' and the percentage recovery, the estimated amounts of lindane in the tissues of the animals exposed to the aerosol were as follows:

The 'soft parts' include, with the exception noted, the heart, liver, alimentary canal, lungs, urinogenital system and brain. These were in fact analysed separately but are presented together as a weighted mean value for the 'soft parts' because the very small samples available coupled with the low concentration of insecticide therein naturally decreased the precision of the estimates. However, there were indications that the lindane content of the alimentary canal was low in both budgerigars 1 and 2 and the mouse (57, 57 and 81 μg/g.)

TABLE V
Survival of Budgerigars in Room PM

Sex	*Date of entry*	*Date of death*	*Period of survival Days*
M	19.11.56	26.11.56	7
F	19.11.56	25.11.56	6
M	18.12.56	26.12.56	8
F	18.12.56	22.12.56	4
M	2. 5.57	5. 5.57	3
F	2. 5 57	15. 5.57	13
M	18. 7.57	29. 9.57	73
F	18. 7.57	20. 7.57	2
M	2.12.57	3. 1.58	32
F	2.12.57	6. 1.58	35
M	2. 1.58	16. 1.58	14
F	2. 1.58	17. 1.58	15

TABLE VI

Lindane found in Treated Animals
(Micrograms per gram.)

Organ or Tissue	*Budgerigars*				*Mouse*
	1	2	3	*Mean*	
Skin & feathers (or fur)	580	607	576	588	14
Muscle & bone	195	136	150	160	25
Soft parts	197	144	—	171	107*

*Excessive suspended matter gave a spuriously high reading for the mouse's brain which is therefore omitted.

and that of the lungs in the mouse was rather high (376 μg/g.).

(*c*) *Laboratory Workers.*—No adverse effects were noted in any of the laboratory staff subjectively or otherwise although the total exposure in room PM for R.S. and C.R. was roughly equivalent to the exposure producing 16 per cent mortality in budgerigars and the total exposure for J.A.F. was about the same as that which caused 50 per cent mortality in budgerigars in the same room.

(*d*) *House Flies.*—The knockdown of flies exposed to the toxic surfaces is detailed in Tables VII, VIII and IX. Each entry under the heading 'Knockdown' is shown in the form of a fraction $(r_1 + r_2)/2n$ where r_1 and r_2 are the numbers of flies knocked down at one and two hours respectively after exposure to the treated surfaces, and n is the number of flies participating in the test. Since r_2 refers to the same group of flies as r_1, the two observations are not independent; the values of χ^2 calculated to test the significance of differences between the observations were therefore based on the number of insects n.

TABLE VIII

Responses of Houseflies to Aldrin Deposits

Designation	*Knockdown*	*Percentage*
Glass	15/80	18·8
Wood	9/80	11·2
Fibreboard	4/80	5·0
Asbestos-cement	9/80	11·2
Horizontal ...	27/160	16·9
Vertical	10/160	6·3
3 months exposure	11/160	6·9
6 months exposure	26/160	16·2
Total	37/320	11·6

Discussion

(*a*) *D.D.T./Lindane Mixture.*—Animals were exposed to three dose levels of the output of vaporizers using a mixture of 40 per cent D.D.T. with 60 per cent lindane and the effects were observed with the object of estimating the approximate upper limit of safe dosage. At the same time it was necessary to confirm that lower doses would be insecticidally effective.

As mean ventilation rates were not known it was desirable to have some assurance that the doses received by the test animals were suitably related to the doses dispensed by the vaporizers. Evidence was provided by the fly tests which showed the probit of

TABLE VII

Responses of Houseflies to D.D.T./Lindane Deposits

Designation	*Knockdown*			*Total (as percentage)*
	Room PM	*Room R*	*Room S*	
Glass	160/160	155/160	128/160	92·3%
Wood	159/160	142/160	90/120	88·9%
Fibre board	137/160	122/160	119/160	78·8%
Asbestos-cement	150/160	156/160	128/160	90·4%
Horizontal	313/320	312/320	244/280	94·5%
Vertical	293/320	263/320	221/320	80·9%
3 months exposure	129/160	128/160	61/140	69·1%
6 months exposure	157/160	145/160	96/140	86·5%
9 months exposure	160/160	159/160	159/160	99·6%
12 months exposure	160/160	143/160	149/160	94·2%
Total (as percentage)	94·7%	89·8%	77·5%	87·6%

TABLE IX

Responses of Houseflies to D.D.T./Lindane Deposits One and Three months after Removal to Clean Atmosphere

Designation	*Knockdown*			*Total (as percentage)*
	Room PM	*Room R*	*Room 5*	
Glass	60/80	18/80	35/80	47·1%
Wood	76/80	60/80	63/80	82·9%
Fibre board	78/80	48/80	42/80	70·0%
Asbestos-cement	50/80	74/80	34/80	65·8%
Horizontal	151/160	135/160	120/160	84·6%
Vertical	113/160	65/160	54/160	48·3%
1 month	129/160	104/160	70/160	63·1%
3 months	135/160	96/160	104/160	69·8%
Total (as percentage)	82·5%	62·5%	54·4%	66·5%

the response of the flies to the surface deposits to be directly proportional to the logarithms of the weights of insecticide volatilized per day per unit volume. This may be seen in Fig. 2 where the upper line represents the fly tests carried out during the main experiment and the lower line shows results from those performed on the deposits after storage in a clean atmosphere. The smaller slope of the lower line is to be expected if the rate of vaporization of lindane decreases as the storage time becomes longer, or as the proportion of lindane in the deposit becomes smaller. It is likely that both these processes occur by analogy with the losses from spray deposits (Gunther and Blinn, 1955), from insecticidal lacquers and from thermal vaporization of insecticides as already mentioned.

The 12 budgerigars receiving the highest dose (=0·754 g.d.t.) all died. They had been introduced in couples, one male and one female, on each of six occasions spread over the experimental period. Survival times had a very wide range (2-73 days) with a mean of 18 days. Analysis of variance indicated that there was no significant difference in survival time between males and females nor was there significant variation between occasions although a slow increase in deposit was indicated by the fly tests. Chemical analysis of three budgerigars showed that both 'internal' and 'external' lindane for one of these individuals lay between the levels found for the other two which were exposed together on another occasion. Finally, there was no correlation between survival time and the vaporizer output at the material time of exposure. These findings point to the existence of some kind of buffering mechanism which effectively minimizes variations in biological response. From physico-chemical considerations it is to be expected that there will generally be a dynamic equilibrium between lindane in the surface deposits and lindane dispersed in the air. The vapour pressure of the latter, in the condition of equilibrium would be determined by the partial pressure of lindane in the deposit. This partial pressure will depend chiefly on the temperature of the surface and the proportion of lindane dissolved in the deposit. It thus seems reasonable to conclude that the presence on the room surface of a lipophilic layer in which lindane can dissolve will exert a stabilizing effect on the concentration of atmospheric lindane. The D.D.T./lindane deposits, upon removal to a lindane-free atmosphere would be expected to begin to give off lindane vapour immediately, thereby decreasing in potency; the 'post experimental' fly tests showed that this did in fact occur.

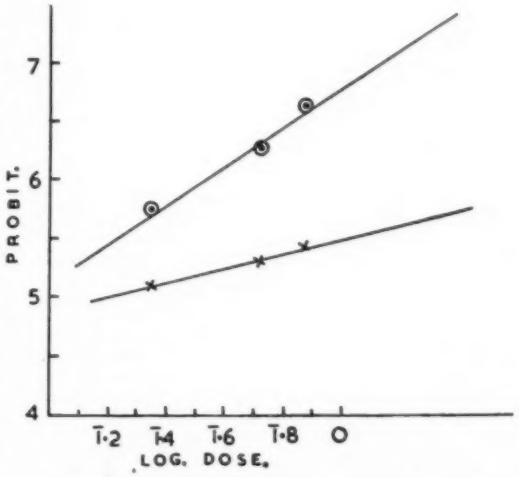

Fig. 2. Dosage — response curves of houseflies exposed to surface deposits produced by D.D.T./lindane mixture at ·224, ·531 and ·754 g.d.t. Upper line: Deposits tested during main experimental period. Lower line: Tests performed after storing deposits in a clear atmosphere.

The feathers of the budgerigars were found to take a residual deposit of lindane quite readily, assisted no doubt by the presence of some D.D.T. The high ratio of surface to mass, the excellent heat insulation properties —which would protect the outer layers from body heat —and the probable existence of a lipoid layer on the feathers provides an adequate explanation for this. The relatively high internal concentration of lindane is believed to be due to preening rather than absorption through the skin; the low values found in the gut do not exclude the oral route as a means of entry, but suggest that intestinal absorption is rapid. Birds such as budgerigars that preen themselves frequently, and mammals such as the cat which 'wash' themselves regularly, are presumed to be more susceptible than other species to the effect of surface deposition of toxic substances.

Of the four mice exposed in Room PM, one died, and although it is believed that this death was probably non-specific the possibility that the pesticide may have contributed to some extent cannot entirely be excluded. In comparison with the birds there was very little external deposit on the mouse while the evidence for deposition in the lungs is not very strong. As the body heat readily passes out and warms the fur it is unlikely that deposition would occur to the same extent as on budgerigars' feathers; the lipoid layer, too, appears to be lacking and differential behaviour would influence the uptake of superficial deposits.

The wide variation in survival times of budgerigars in Room PM seems, at first sight, to conflict with the observation that the increase of response level was large (0 per cent to 100 per cent) for the small increase in dose (0·531 to 0·754) between Room R and Room PM. Further trials with larger numbers of budgerigars and mice are clearly needed if the unusually steep slope is to be estimated more precisely, but assuming it to be confirmed it may be helpful to consider the result of a relatively small deviation from the balance between the rate of input of insecticide into a system and the rate of elimination therefrom. Two such systems are involved in the present instance, namely, the surface deposits in the treated room and the body tissues of the animals. In both cases small percentage changes in the input rate can clearly give rise to large percentage changes in the rate of accumulation of insecticide as the latter is a small difference between two large values. Although the conditions of the experiment prevented precise observation of the amount of preening which occurred it seems possible that slightly increased preening at the highest dose might result in considerable increase in the rate of accumulation of insecticide. It was observed that in Room PM there was some 'fluffing' (i.e. accumulation of feathery aggregates of insecticide crystals) which might in itself have induced more frequent or energetic preening; 'fluffing' was not seen in the other rooms.

Additional evidence from outside sources has been made available from the Chester Beatty Research Institute, the M.R.D., Porton and the M.R.C. Unit a Harwell, where vaporizers have been in use for insect control in experimental and stock animal rooms. There has been no suggestion of any toxic manifestations among rats, mice, rabbits, hamsters and guinea pigs, continuously exposed to the vaporizer output of D.D.T./Lindane mixtures for long periods.

(*b*) *Aldrin and Azoxybenzene.*—The doses of aldrin and azoxybenzene were 0·500 and 0·429 g.d.t. respectively. As they have both about the same volatility as lindane but were vaporized alone there was no change of output rate or of composition during the heating period, and there was little tendency to form residual deposits, the fixative action of low vapour pressure adjuvants being absent. While the low fly responses to the exposed plates are thus only to be expected they are insufficient to show that, with the addition of the atmospheric insecticide which would have its effect during normal operation, lower doses would give a satisfactory level of pest control. Previous trials of aldrin have shown that in comparison with lindane it is rather inferior in potency for the first few hours but ultimately appears to be slightly superior. Houseflies were used in these trials and the insecticides were heat volatilized. Field trials of azoxybenzene have indicated that it will control red spider mite (*Tetranychustelarius*, L.) in glasshouses within two or three days at the above dose level.

No comment appears to be necessary with regard to mammalian and avian toxicity of these two compounds as the results were completely negative.

CONCLUSIONS

1. There is a range of doses of D.D.T./lindane mixture in which it appears that effective fly control can be combined with safe operation. The upper limit of this range is estimated to lie between 0·53 and 0·75 g.d.t. for budgerigars and perhaps for mice. The upper limit for dogs lies above 0·22 g.d.t., for rats above 0·53 g.d.t., and for human beings above 0·75 g.d.t. when exposed intermittently for a total of at least 206 hours. In practical operation it is tentatively suggested that a dose of 0·2 g.d.t. should not be exceeded.

2. From the unexpected uniformity of some biological effects, a buffering action of the surface deposit upon the aerial concentration of lindane is postulated and a possible mechanism for this phenomenon is suggested.

3. The intake of lindane by budgerigars is higher than that of mice, probably because the insecticide accumulates readily on the feathers entering the body by the oral route as a result of preening.

4. Vaporized aldrin at 0·50 g.d.t. and azoxybenzene at 0·43 g.d.t. as successfully used to control horticultural pests do not appear to offer any toxic hazard to man, budgerigars, mice, hamsters or guinea pigs.

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(*Concluded on page* 26)

LABORATORY EQUIPMENT TEST REPORT—No. 35

POTENTIOMETRIC MICROTITRATION APPARATUS

For the determination of chloride in plasma, serum, urine, C.S.F., etc. and other potentiometric titrations. The apparatus was designed in co-operation with Dr. I. D. P. Wootton, Postgraduate Medical School of London

Manufacturers: A. Gallenkamp & Co., Ltd., Sun Street, London, E.C.2

Price: £97. 15s.

THIS apparatus (Fig. 1) has been designed for the accurate determination of chloride in micro- (i.e. 0·2 ml.) specimens of biological fluids after the method of Sanderson (1952), a method which is recommended by King and Wootton (1957). It can of course be used for chloride determinations in less complex fluids but bromide, iodide and thiosulphate will interfere. The principle is as follows. The unknown sample is diluted with nitric acid in a small beaker and stirred magnetically. Silver nitrate (0·01 N) is added beneath the surface of the solution from a special burette, with sealed-in platinum electrode. The electrical potential between the platinum electrode in the silver nitrate solution and a silver electrode dipping into the sample is measured continuously with an electronic millivoltmeter of high resistance. The potential is high at the start, drops slowly as the silver nitrate is first added and then rapidly as the concentration of silver ions suddenly rises when precipitation of silver chloride is complete. The end-point of the titration is taken when the potential reaches a predetermined value corresponding to exact equivalence between the solutions; this value is established by an earlier titration where the theoretical equivalent of the silver nitrate is added to a known volume of standard chloride solution.

The apparatus consists of two main components, a titration stand and an electronic potentiometer. The stand, which is very stable, has a magnetic stirrer built into the base, a sliding burette carrier and a hook to support a 25 ml. reservoir for the self-filling burette (Fig. 2). The novel burette-carrier, which has a grooved white back-plate for easy reading of the meniscus, moves freely along a set course, swinging away to one side to hold the burette out of the way in the up-position and lowering it to a fixed point above the centre of the base in the down-position. The fine-tipped 5 ml. burette graduated at intervals of 0·02 ml. has a two-way tap enabling it to be filled conveniently from the reservoir, a sealed-in platinum electrode and a plastic cuff to support the silver electrode. The potentiometer is an electronic millivoltmeter with stabilized power supply housed in a stove-enamelled case. On the front panel are a sliding scale for mechanical zeroing of the reflecting galvanometer, and controls for the electrical zeroing of the circuit and adjustment of the scale width and on/off switches for the stirrer motor and the mains connection. Both switches are linked with pilot lamps, that for the motor being situated at the base of the stand. Other items supplied with the apparatus include six 8 mm. polythene-covered magnetic followers, a dozen 10 ml. Pyrex beakers, two spare silver electrodes and an instruction manual. The last gives complete details of the method for use with the instrument, including directions for making up the solutions required—a welcome feature from a British manufacturer.

Fig. 1. Potentiometric microtitration apparatus.

The apparatus was put on trial in a busy clinical chemistry laboratory over a period of eight months. Several hundred chloride determinations were made with the apparatus by several graduates, medical and chemical. The apparatus was also successfully used by technical staff.

The construction proved robust and the apparatus was still functioning perfectly at the end of the trial.

Mechanical, electrical and glass components as well as the finish were all in excellent condition. The only part which required replacement during the trial was the small connector for the silver electrode; as a result of corrosion this fractured during changing of the electrode.

The design of the apparatus has been well thought out for routine use, particularly pleasing features being the easy and safe method of raising and lowering the burette and the quick steady response of the galvanometer. The manner of fixing the upright rod to the base of the stand is awkward however. On several occasions the rod worked loose and tightening the securing nut involves removal of the base plate; even then the nut is difficult to reach. The polythene-coated magnetic followers were not uniformly satisfactory—one which was slightly longer than the rest refused to spin and others were found liable to cause splashing of the contents of the beakers at the commencement of the titrations; smaller glass followers offered as an alternative in the later stages of the trial proved free of this latter objection and produced adequate stirring. The only other improvement that can be suggesed is the provison of an adjustable foot for raising the front of the instrument panel; this would make the operation of the instrument more comfortable where the potentiometer cannot be placed on a support above bench height.

Regarding the method itself, this was found very satisfactory for clinical work, the particular advantages being:

1. Only a small volume of sample is required.
2. Protein removal is unnecessary—consequently there is less manipulation and less opportunity for error.
3. The end-point is unequivocal.

In connection with the first point the apparatus was found to give identical results with samples of 0·1 or 0·2 ml. A technique was also tried where 5 ml. of a 1 in 25 aqueous dilution of 1 ml. of plasma was taken as the sample. In these circumstances 0·5 ml. of 2N nitric acid was added before titration (in place of the usual 5 ml. of 0·2N nitric acid). This modification proved equally satisfactory and very attractive where sodium and potassium had to be determined, by flame photometry, on the same 1 ml. specimen; 5 ml. samples of the primary dilution were used for chloride and potassium determinations and a further 5 ml. was diluted to 100 ml. for sodium estimation.

The apparatus gave results of excellent reproducibility; with a careful operator, duplicate or triplicate results were within 1 mEq./L. for plasma levels of about 100 mEq./L.

In order to assess the absolute accuracy of chloride estimations with the apparatus, the chloride content of 85 plasma samples was estimated in parallel by Volhard titration after oxidation by the open Carius method (method of Van Slyke (1923-24) with digestion over an open flame as described by Eisenman (1929)). The potentiometric apparatus gave results which were consistently 2-3 mEq./L. higher. There is reason to believe however that the potentiometric method was

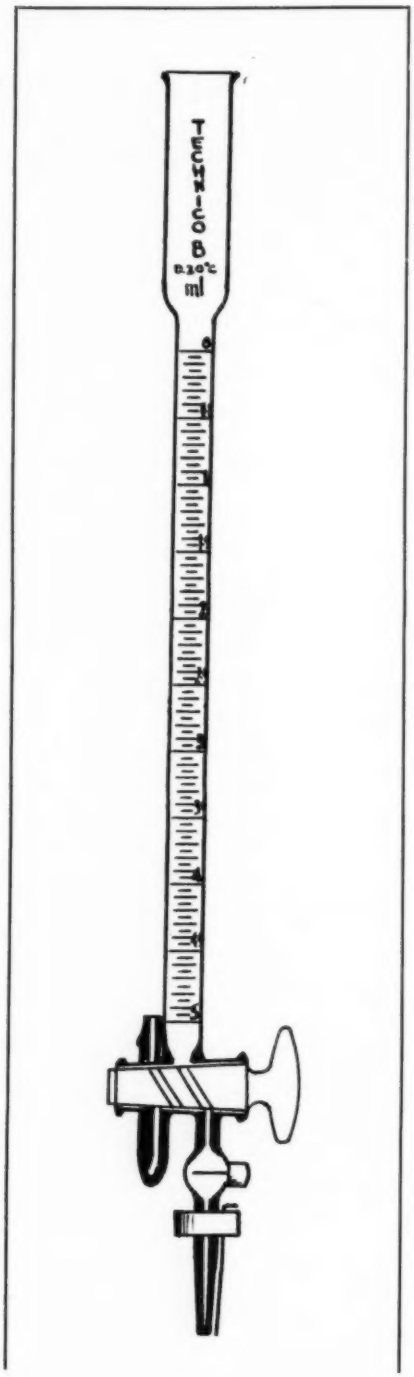

Fig. 2.

giving the true chloride value; thus, Van Slyke and Hiller (1947) found that chloride values 2-3 mEq./L. too low may be obtained by the method of Van Slyke (1923-24) unless digestion is greatly prolonged, i.e. to overnight on a steam-bath. To check this point 24 of the plasma specimens also had their chloride content estimated by a third method—titration with silver nitrate after deproteinization with zinc sulphate and barium hydroxide, using dichlorofluorescein as indicator (method of Franco and Klein (1951)). The results obtained with this method were much closer to those found with the potentiometric apparatus, being only 1 mEq./L. lower. It appears therefore that the electrometric method provides a true chloride figure.

Conclusion

The general impression of this apparatus was that the design and construction were very good, and that it provided reliable and accurate chloride determinations on micro-samples of biological fluids.

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Forthcoming Conferences and Congresses

Some Aspects of Magnetism

The Institute of Physics announces that it is arranging a Conference on 'Some aspects of magnetism' to take place in Sheffield from September 22 to 24, 1959.

The subjects to be covered by the conference are:

(*a*) Fundamental theories of ferro-, ferri- and antiferromagnetism including magnetic structure.
(*b*) Theories of technical magnetization processes, including hysteresis, coercivity, anisotropy and directional effects.
(*c*) Theoretical and experimental studies of domain phenomena in bulk materials and thin films.
(*d*) Experimental and theoretical studies of antiferromagnetism in metals and non-metals.

Each session will be opened by an invited speaker and offers of other contributions should be submitted to the Conference Secretary at The Institute of Physics, 47 Belgrave Square, London, S.W.1, before January 31 next. The conference is intended mainly for persons working in the field. Abstracts (but not preprints) will be circulated before the conference, the proceedings of which will not be published in full.

Current Developments in the Production of High Vacua

The Institute of Physics announces that it is arranging a one-day symposium entitled 'Current developments in the production of high vacua' to take place in London on April 17, 1959.

There will be three sessions:

(*a*) Chemical and ionic pumping in kinetic vacuum systems.
(*b*) Problems in the production of high vacua in large equipment.
(*c*) Analysis of residual gases in kinetic vacuum systems.

Each of the first two sessions will be opened by invited speakers, and offers of short contributions, especially for the third session, will be considered by the Organizing Committee if outlines are submitted by January 15 next.

The symposium is intended mainly for persons working with high vacua. Abstracts (but not preprints) will be circulated before the symposium, the proceedings of which will not be published in full.

All communications regarding the symposium should be sent to the Secretary, The Institute of Physics, 47 Belgrave Square, London, S.W.1.

Congress of Polarography

The Second International Congress of Polarography, organized by the Polarographic Society, will be held in the University of Cambridge from August 24 to 29 and will consist of Scientific Sessions (original papers, reviews and discussions) and Exhibition of Commercial Equipment, Demonstrations of Laboratory Apparatus, visits to local industry and places of interest and social functions.

A supporting programme for ladies is being arranged.

The scientific programme will be divided into the following sections:

1. Instrumentation.
2. Theory and Kinetics.
3. Analytical and Industrial Applications.
4. Fundamental Studies.
5. Biological and Medical Applications.
6. Miscellaneous.

There will also be four plenary lectures by world authorities and six section lectures.

Contributions will be welcome and details should be submitted to:

G. F. Reynolds, M.Sc., F.R.I.C.,
Chemical Inspectorate,
Ministry of Supply,
C. 36. Royal Arsenal,
Woolwich,
London, S.E.18.

Notification of intention to submit a communication should be made as soon as possible and in any case not later than March 31, 1959, by which date a summary not exceeding 200 words is also required.

Preprints of all papers will be issued and final manuscripts must therefore be received not later than May 31, 1959.

There will be an exhibition of commercial equipment and ancillary materials.

Requests for application forms and further details should be sent to:

Mrs. B. Lamb, B.Sc., F.R.I.C.,
Chemistry Laboratory,
Eversheds and Vignoles,
Corner of Iveagh Avenue,
North Circular Road,
London, N.W.10.

Recent British Standards

Methods of Testing Plastics

This new publication (B.S.2782, Part 5:1958, price 10s. 46 pp. illustrated) marks another step towards the fulfilment of B.S.I's intention to issue *in one standard* the methods of test currently used by the plastics industry. As the title suggests, the standard deals with tests which did not conveniently fall into the sub-divisions chosen for the previous four parts.

In general, the presentation of contents follows the established pattern: details of test specimen, apparatus, procedure, methods of calculating the result and of reporting it. Specifically the publication deals with the following properties: Apparent density and bulk factor; water absorption and water soluble matter; boiling water absorption; water vapour absorption; resistance to chemicals; colour bleeding; colour fastness to light; flammability; density.

Copies of these Standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

ARTICLES

Methods used for the Assay of Extracts which contain the Hormones of the Posterior Pituitary Gland

by Fay Johnston, B.Sc.

Department of Materia Medica, University of Glasgow

PART IV

Assays using Rats (Burn 1931)

The first assay method for posterior pituitary extract which used rats was introduced by J. H. Burn. It was based on Gibb's observations (1930) on the effect of the extract on water loaded mice which has been previously described.

Burn's aim was to introduce a more quantitative assay, and to use an animal which would give a higher rate of urine output than the mouse. He used both male and female animals of 140 to 240 g. in weight but found that the female rats gave inconsistent results and that males were more reliable to work with. He also found that by starving the animals for several hours before the experiment, but allowing them access to water, the results were more accurate.

In spite of the fact that many variations of the Burn method have been introduced, these two principles of using male rats and of deprivation of food have been fairly rigidly adhered to.

The method is described as follows. Sixteen rats were given a water load of 5 ml. per 100 g. body weight by stomach tube. This was administered by means of a No. 3 gum elastic catheter fitted on to a 10 ml. syringe. This size of catheter will not pass down the trachea. The end of the catheter was moistened with glycerin to facilitate its passage down the oesophagus. The rats were then placed in metabolism cages in groups of four, two groups receiving subcutaneous injections of the standard vasopressin and two groups receiving injections of the solution to be assayed. Doses of the order of 0·006 units per 100 g. body weight were found to be suitable. The time at which the rats received their water load and injections was recorded and the time interval which elapsed until the point of maximum excretion of urine was noted.

The next day the procedure was repeated on the same rats, but those which had received the standard were now injected with the unknown solutions, and vice versa. This diminished the error in the experiment by testing both the standard and the unknown extracts on the same animals. This procedure was introduced by Marks (1926) and makes the assay results more accurate.

Gilman and Goodman (1937)

Many variations of the Burn method have been introduced in attempts to increase its accuracy. Gilman and Goodman, for example, using the same calculation as Burn, found that more accurate results were obtained by giving a preliminary dose of water to the rats, three or four hours before the assay.

Teel and Reid (1949)

Teel and Reid adopted this modification and introduced the administration of two water loads of 5 and 3 per cent body weight respectively, one hour apart. They found that this produced a more uniform hydration in the rats and that an established diuresis was inhibited by the antidiuretic substance.

The test and standard solutions were given intramuscularly when a good diuresis had been established, usually about 20 minutes after the second water load. They calculated the amount of water to be excreted as the total of the two doses given, less the amount excreted at the time of injection.

Ham and Landis (1942)

Ham and Landis, still basing their assay on that of Burn (1931), grouped their rats in threes so that the total weight of each group of three rats did not differ by more than 10 per cent. Six of these groups were set up, two being used as controls, leaving four groups for duplicate assays of two unknown solutions.

To begin the assay, each rat received a 'priming' dose of 0·2 per cent sodium chloride solution by stomach tube. This was calculated as 2·5 per cent of the body weight. The authors found that this yielded more consistent results than did water loading with tap water. Two hours after the first dose of saline, all the urine excreted up to that time was discarded, as the volume excreted in this preliminary period varied considerably. Each rat was then given a 'hydrating dose' of 0·2 per cent sodium chloride solution equivalent to 5 per cent of the body weight. At the same time, the solution to be assayed was injected intraperitoneally in a volume totalling 1 ml. per 100 g. body weight. Control groups treated in a similar fashion were given intraperitoneal injections of 0·9 per cent sodium chloride to match the composition of the solutions being tested. Starting at zero time for each cage, the cumulative volume of urine excreted was recorded at 15 minute intervals for three hours. The recorded volumes were computed in terms of the amount excreted per 100 g. of rat and plotted against time for each group of three. To express the results by a single number, the areas of these curves were measured in square inches using a planimeter.

It was found that this method was accurate with doses of 0·5 to 10 milli-units of vasopressin. The rats were used for not more than three assays at intervals of ten days or more.

Birnie, Eversole, Ross, Osborne, and Gaunt (1950)
These workers waterloaded the rats by giving them 3 ml. per 100 sq. cm. of body surface. Two such doses were administered one hour apart and the animals were kept in individual metabolism cages. One hour after administration of the second dose of water, urine output was measured and any rat which had a urine output which varied by more than 50 per cent from the mean of groups of six rats, was discarded. The test material was then injected intraperitoneally and a third water load was given.

Urine output was measured at 30 minute intervals for a period of three hours and the urine excreted at any period was calculated as a percentage of the total water given, minus the percentage excreted prior to injection of the test material. The percentage of water excreted at 90 minutes after the injection of the test material was adopted as the definitive figure, and in ordinary experiments the authors found that there was little to be gained by continuing observations beyond that time. It was found that this method produced a high rate of diuresis in the animals and permitted better determination of the potency of the antidiuretic substance than did the ordinary Burn assay procedure.

Ginsburg (1951)
Ginsburg's method entailed using 18 adult male rats of 200 g. weight. These were given water loads before the experiment in order to condition them, as sometimes nervousness in the animal during water loading will produce an antidiuretic effect. The animals were deprived of food for 18 hours before the experiment, and water was removed one hour beforehand. The rats were then placed in individual metabolism cages and the urine collected in graduated cylinders. Each animal was given two doses of tepid water (5 ml. per 100 g. body weight) at one hour intervals. A similar dose of water was then given and the rats were injected subcutaneously with the test material. Urine output for each animal was measured at intervals of 30 minutes for 120 or 150 minutes.

The volume of urine, V_2, was expressed as the percentage of the amount of water administered in the first two water loads. Those rats for which this value deviated from the mean of the whole group by more than 33 per cent were discarded. Since the rats were injected subcutaneously, the method of calculation adopted allowed 30 minutes for complete absorption of the injected materials.

Calculation

$$\text{Percentage of water excretion} = \frac{V_E - V_{30}}{3V_1 - (V_2 + V_{30})} \times \frac{100}{1}$$

where V_1 = volume of water administered in each dose
V_2 = volume of urine excreted in the two hours before injection
V_{30} = volume of urine excreted in the first 30 min. after injection
V_E = volume of urine excreted during the period.

Thus the percentage of water excretion at a given time is the volume of urine passed from 30 minutes after injection expressed as a percentage of water administered, minus that excreted, at 30 minutes after injection.

In each assay two dose levels of standard and unknown were used, the value of the ratio of these doses being either 2·0 or 3·0. A four-point assay was carried out and the mean standard error in 12 assays was 8·9 per cent. A total antidiuretic activity in the unknown corresponding to about 10 milli units of vasopressin was sufficient for a satisfactory assay.

This method was adopted by the 1953 British Pharmacopoeia for the official assay of vasopressin.

Leaf and Mamby (1952)
Leaf and Mamby used hypophysectomized rats for their assay. The animals, weighing about 200 g., were given 8 ml. of water by stomach tube per 100 sq. cm. surface area (11.23 × weight 2/3), following 12 hours of fasting. Two-fifths of this water was administered initially and one-fifth at subsequent hourly intervals. Normal saline was injected intraperitoneally at the start of the third hour of hydration. The unknown solution was injected intraperitoneally at the beginning of the fourth hour. The rats were placed in metabolism cages over funnels and urine collected during the third and fourth hours.

The total solute concentration of each urine sample was determined and the mean increase in concentration of the samples during the hour following injection of the test material was compared with that of the preceding control hour samples. This was taken as the antidiuretic index.

Stein, Jinks, and Mirsky (1952)
These workers gave two water loads to the experimental animals. These consisted of 0·2 per cent sodium chloride solution (5 ml. per 100 g. body weight). The antidiuretic response was expressed as the reciprocal of the ratio of the volume of urine excreted after 60 minutes to that excreted at 20 minutes following the second water load. The response had a linear relationship to the logarithm of the dosage of antidiuretic substance.

By means of the Bliss (1944) design with ten rats receiving a standard and ten receiving an unknown quantity of antidiuretic substance, the mean standard error of the potency ratio was ± 30·27 per cent and the index of precision (λ) was 0·33.

McCreary, Adams and Overman (1957)
Lately some doubt has been cast on the idea that male rats are more suitable for use in these assays than female rats. McCreary and his co-workers found female animals to be eminently suitable for this experiment. These animals were housed in a controlled temperature laboratory and given free access to food and water.

Four rats were used for each determination so as to

minimize possible error arising from individual variation. The animals were given water amounting to 5 per cent body weight by stomach tube. Two rats were placed in each metabolism cage and urine was collected and measured at 15 minute intervals for a three-hour period. Following one hour of rest, the same animals were rehydrated in the same manner, and the urinary output was again measured for a three hour period. The urinary output was plotted against time on arithmetic millimeter paper. The area beneath these two curves was measured with a Keuffer-Esser planimeter. The volume-time relationship could thus be compared. It was found that the total urine output for each three hour period was approximately 90 per cent of the amount ingested and the output following the second hydration was equal to the first. Thus the first curve could be used as a control and the second for the determination of antidiuretic activity.

This procedure was repeated, but at the time of the first hydration, 2·5 ml. of water were injected subcutaneously along the dorsal spine, and at the time of the second hydration 2·5 ml. of the solution to be tested were injected. A comparison of the area beneath the output curves gave the degree of antidiuretic activity in the solution. This was expressed as a percentage effect.

Another type of vasopressin assay, using rats, is being very widely used today. Instead of 18 rats being used, the entire procedure is carried out on one animal. This method has the added advantage that injections are given intravenously and that standard and unknown solutions of the hormone can be injected into the same rat.

Jeffers, Livezey and Austin (1942)

The first assay of this type was described by Jeffers, Livezey and Austin. These workers found that by rendering rats diuretic by the administration of water and ethanol, it was possible to detect the antidiuretic action of as little as 20 micro units of vasopressin when given intravenously. It was later noted by Van Dyke and Ames (1951) that ethanol suppresses the secretion of endogenous antidiuretic hormone from the posterior pituitary gland, thus rendering the animal more sensitive to the antidiuretic activity of the vasopressin injected during the assay.

Male rats of 180 to 220 g. were used and these were starved for 18 hours prior to the assay. During the experiment they were kept at a constant temperature of 29 to 30°C. Solutions administered by stomach tube were given at a temperature of 40°C.

An initial load of ethanol-water solution was administered by stomach tube. This was 5 per cent of the animal's body weight and consisted of 12 per cent of 95 per cent ethanol in water. Thirty minutes later, 3 per cent of the animal's weight of water was administered. After the animal, which by then was unconscious, was placed in the supine position, an intravenous needle (23 gauge, 1½ in. long) was introduced into the femoral vein, the skin having been previously incised. The glass-tipped connection of a rubber cystostomy tube of 1/16 in. bore was tied into the urinary bladder through a suprapubic incision. The bladder was then replaced and the wound closed by a single suture. The urethra was occluded by means of a ligature. The collecting cylinder, graduated to 0·1 ml., was set on a stand allowing vertical movement, so that the outlet of the cystostomy tube remained approximately 7 cm. below the animal's bladder throughout the experiment.

Measurements of cumulative urine volumes were made at ten minute intervals and until a steady flow of 3·1 to 8·1 ml. per hour was obtained. This usually occurred about 90 to 120 minutes after the first water load. The first injection of vasopressin was then given and readings were made at four-minute intervals during the period of antidiuresis. To calculate the degree of antidiuresis, the volume of urine excreted 20 minutes after injection was subtracted from that for the same period prior to injection. A maximum of four injections was given to each animal.

(To be continued)

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Royal Society Medals

The following awards of medals have been made by the President and the Council of the Royal Society:

The Copley Medal to Prof. J. E. Littlewood, F.R.S., lately Rouse Ball professor of mathematics in the University of Cambridge, for his distinguished contributions to many branches of analysis, including Tauberian theory, the Riemann zeta function, and non-linear differential equations.

The Rumford Medal to Sir Thomas Merton, K.B.E., F.R.S., formerly professor of spectroscopy at Oxford University, for his distinguished researches in spectroscopy and optics.

The Davy Medal to Prof. R. G. W. Norrish, F.R.S., professor of physical chemistry in the University of Cambridge, for his distinguished work in chemical kinetics, especially in photochemistry.

The Darwin Medal to Sir Gavin de Beer, F.R.S., director of the British Museum (Natural History), for his distinguished contributions to evolutionary biology.

The Sylvester Medal to Prof. H. M. A. Newman, F.R.S., Fielden professor of mathematics in the University of Manchester, for his distinguished contributions to combinatory topology, Boolean algebras and mathematical logic.

The Hughes Medal to Prof. E. N. da C. Andrade, F.R.S., emeritus professor of physics in the University of London, for his distinguished contributions to many branches of classical physics.

PSYCHOLOGICAL ASPECTS OF LABORATORY WORK

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PART IV—PSYCHOPHYSICAL METHODS AND LABORATORY PRACTICE

Introduction

This article starts with a review of the classical psychophysical methods, dating them rather conveniently with the publication of Fechner's 'Elemente der Psychophysik' (1860). The main measures derived from the three principal methods are outlined and the similarities and differences between the three methods are examined. Attention is drawn to a wide range of laboratory procedures which, directly or indirectly, employ the basic operations and measures systematically evaluated in one or other of the psychophysical methods. The close relationship between one of the classical psychophysical methods (The Constant Method) and modern techniques of bio-assay is discussed. The role of standardization of procedures in the psychophysical methods is examined and a clear distinction between the probable interests of the (pure) physicist and the psychologist in certain psychophysical studies is discussed under the heading of 'stimulus error'. This refers to a common but erroneous belief that it is the task of a person being tested in a psychophysical study to attempt to appraise what is happening to the stimuli being varied rather than to describe and/or respond to his own experiences (sensations) following stimulation. The term 'sensation' is avoided as far as possible for it carries with it many unwanted assumptions which hinder clear thinking about the issues considered here. Limitation of space unfortunately precludes the discussion of the interesting question whether threshold measures may legitimately be used as an indication of something else. To give one example, in which such evidence as there is provides a contra-indication, have measures of taste and odour sensitivity any bearing upon the choice of suitable persons for making sensory assessment of foodstuffs? This also raises the question of the logic of, and available methods for, systematizing sense experience relating to levels far beyond the threshold or 'just noticeable' range, of which stellar magnitudes form an early example. This question also must be omitted from discussion here. The interested reader will find admirable reviews of many of the major points in Stevens (1957, a and b).

The Classical Psychophysical Methods

The classical psychophysical methods form a group of procedures for obtaining and analysing human response data resulting from controlled and variable levels of stimulation. The term 'psychophysical' implies that these methods are restricted to physical stimuli but they may refer equally to all measureable forms of stimulation (e.g. chemical, pharmacological, etc.) which evoke a sensory response. Thus to describe these methods as 'psychophysical' is simply to use an accepted label whose significance is primarily historical. Three of the methods concerned were first formalized in 1860 with the publication of Fechner's 'Elemente der Psychophysik'. The more permanent contributions from this volume have been summarized by Boring (1942, pp. 34 ff.) and will be abridged further here. In addition to establishing three of the principal methods and providing computational techniques Fechner defined three of the fundamental measures which are derived from such studies.

These are:

1. The absolute threshold.
2. The differential threshold.
3. A measure of sensory equivalence.

From the available data on differential thresholds Fechner also established what is now referred to as Weber's Law and derived from it Fechner's Law. A detailed treatment of these last two items cannot be given here, but Weber's Law is a statement of the empirical fact that, in the units in which stimuli are usually measured, the value of a stimulus must be increased by an approximately constant *proportion* for the difference between the effects of the two stimuli to be 'just noticeable'. Fechner's Law is concerned with an attempt to extend this empirical fact by mathematical processes of integration to give an equation relating 'sensation levels' to 'stimulus levels', over a substantial stimulus range. The facts of the Weber ratio and the derivation of Fechner's Law have been discussed elsewhere (Harper, 1950), and it is sufficient to state here that the value of the Weber ratio gives a useful indication of the comparative 'resolving power' of different sensory channels. Of Fechner's Law it should be noted that few psychologists would unhesitatingly accept the assumptions which have to be made in order to integrate an equation originally involving finite steps in stimuli and 'sensation differences'. In spite of this some investigators, who are not psychologists, are inclined to refer to Fechner's formulation as an accepted psychological point of view. However to discuss this topic here would take us far beyond the scope of the classical psychophysical methods.

The three principal methods are:

1. The Method of Average Error or the Method of Adjustment.
2. The Method of Limits.
3. The Method of Constant Stimuli.

Full details of these methods as now employed are given in a number of contemporary textbooks of which

SOME IDEALIZED RESPONSE CURVES

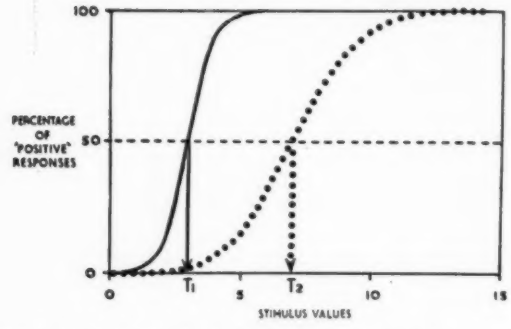

Fig. 1. Absolute Threshold: Two Category Response.

T_1 and T_2 Threshold Values for two individuals of differing sensitivity.

For absolute threshold determinations with two category data (Fig. 1) the stimulus value corresponding to 50 per cent of each type of judgment gives a measure of sensitivity.

In this case, sensitivity is also related to the slope of the sigmoid curve, the steeper the slope the greater the absolute sensitivity.

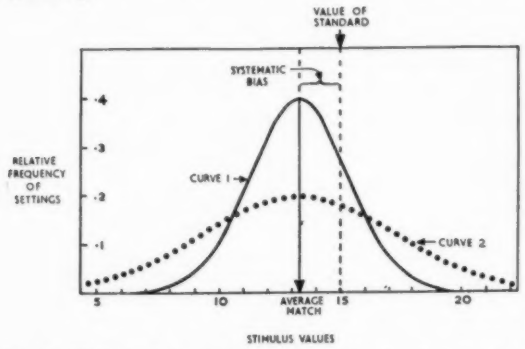

Fig. 2. Method of Average Error: Comparative Judgments. Curves (1) and (2) refer to two individuals of different sensitivity.

Woodworth and Schlosberg (1955) and Guilford (1954) may be noted in particular. It seems most appropriate here simply to outline the main functions of these methods and to indicate any major differences between them. (Some idealized response data are given in Figs. 1, 2 and 3). All methods may be employed either in response situations where only one stimulus is presented at any instant or in those which involve the comparison between the effects of two stimuli. In the single stimulus situation these methods will provide a measure of the absolute threshold. In the comparative situation the appropriate measures of interest are the differential threshold and that of sensory equivalence. If sensory equivalence is determined directly, as in the Method of Average Error, then it may be referred to as a matching point; if the corresponding point is determined indirectly by statistical processes then the phrase 'point of subjective equality' is an appropriate one.

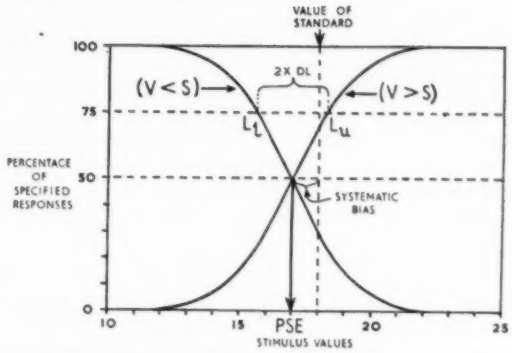

Fig. 3. Constant Method: Two category response.

V = Variable (stimulus)
S = Standard (stimulus)
L = Limen or threshold
L_u = Upper threshold value
L_l = Lower threshold value
DL = Differential threshold $(L_u - L_l)/2$
PSE = Point of subjective equality

In comparative judgments involving two stimuli and only two categories of judgment (Fig. 3) the matching point is defined by the stimulus value corresponding to 50 per cent of each type of judgment and the threshold values (upper and lower) are given by the intercept corresponding (usually) to 75 per cent of each type of judgment. Half the difference between the stimulus value corresponding to this upper and lower threshold gives a measure of the differential threshold. There is no mystical significance in the choice of 75 per cent although this of all points can normally be determined with the greatest possible accuracy. The probability aspects of the threshold is thus emphasized rather than a precise, determinate step.

Similarities and Difference

The main distinction between the Method of Average Error and the other two methods lies in the fact that in the Methods of Average Error the stimulus must be continuously variable and comes under the direct control of 'the subject' who is being tested, whereas in the other two methods discrete and predetermined stimulus values are presented to the subject, who has no control over these values. The main distinction between the Method of Limits and the Constant Method lies in the fact that the former involves the use of regular ascending and descending series of stimuli (starting from different points) whereas in the latter the order of presentation is deliberately haphazard. The choice of method in a particular investigation depends upon a number of considerations amongst which the actual methods (and equipment) available for producing the stimuli employed play an important part. If the equipment available provides continuously variable stimuli then, in principle, any one of these three methods may be employed, provided some means exist of cutting off the stimuli from the subject during the transition from one value to another when the adjustment method is *not* to be used. If, however, only fixed stimuli are available (e.g. a graded series of objects of different

weights, or a series of bottles containing different strengths of taste or odour stimuli) then choice is restricted between the Method of Limits and the Constant Method. A few special points about these various alternatives may be noted. The direct adjustments of the stimulus value in the Method of Average Error seem to have a certain logical simplicity about them, but it has to be remembered that the results obtained by this method incorporate the manipulative skill of the subject. All methods tend to induce a particular attitude of mind in the subject and Pickford (1951, p. 61) has stated, as a result of his extensive work on colour vision, that the Method of Limits creates in the subject tested a frame of mind which is the most conducive to consistency of judgment in matching and discrimination.

In the Method of Limits each set of responses provides a rough guide to the quantities which will be estimated more precisely from the complete data. This is in direct contrast with the Constant Method where the results emerge 'only at the computer's desk'. In both these methods the form of response has to be decided upon and allows of some choice. Different instructions may yield slightly different results, for which precise adjustments cannot be made, and will certainly require modification in computation and analysis. The two most common alternatives are either a two category or a three category response. Thus to such dichotomus alternatives as 'greater or less', 'darker or lighter', 'firmer or softer', 'redder or yellower' may be added an intermediate category to include 'equals or doubtful' judgments. Strictly speaking, these last two form a heterogeneous group whose logical and experiential differences may be distinguished. It will be apparent that an intermediate category is less relevant to absolute judgments involving a response to individual stimuli than to comparative responses. However, the intermediate category can also be introduced here. Strictly speaking the various 'Methods' which have been discussed fall into two distinct parts. The first consists of a standard method of presenting the stimuli concerned; the second consists of standard computational techniques. These have usually assumed that the response-data are related to the stimulus-data in a manner which can be expressed in terms derived from the 'Normal Error Curve'. According to the aims of the investigation computational techniques employed may be elaborate or may be reduced to short-cut procedures which include those of graphical interpolation.

Relation of Laboratory Problems

The principal measures derived from psychophysical studies along classical lines consist of either (1) measures of absolute thresholds, or (2) measures of differential thresholds *and* matching points. One or more of these three measures is directly applicable to the following laboratory topics which are to be found beyond the boundaries of the psychological laboratory.

1. Visual colorimetry.
2. Visual photometry.
3. The definition in physical terms of the main characteristics of normal and defective colour vision, including the formulation of the characteristics of a hypothetical 'average observer'.
4. Audiometric measurements including the establishment of an absolute reference zero usually also related to a hypothetical 'average observer'.
5. The determination of noise or sound levels by direct comparison with a series of physical reference standards. (C.f. recent work at the N.P.L. by Robinson and Dadson, 1956).
6. The analogous problem of determining taste and/or odour levels by similar methods. (Cf. an important paper by Dove, 1953, entitled 'A Universal Gustometric Scale in D-Units').
7. The operation and adjustment of instrumental controls so as to give prescribed readings on the scale and pointer types of instrument.

This list is sufficient to indicate the wide potential application of the psychophysical methods.

Another interesting line of thought concerns the direct relationship between the procedures of the Constant Method and techniques of bio-assay elaborated during the 1930's. Taking into account certain empirical weighting factors developed by Müller and Urban, these resulted in a modification of the computational techniques of the Constant Method into a form almost identical with those now employed in toxicology and related fields. Finney (1952, pp. 42-46) has elaborated this historical link between the Constant Method and modern techniques of analysis in bio-assay in his book on 'Probit Analysis'. It may be added that these two developments occurred in water-tight compartments and it was not until the late 1940's that the link was made explicit. A reference may also be made here to an interesting paper by Harries (1955) in which he discussed 'Sensory tests as biological assays'. He claimed that the biometrician is perhaps more qualified than anyone else to handle problems of sensory testing and to develop new methods as they are required. It is clear from this article that the contemporary experimental psychologist must take exception to any such exclusive claim.

Standardization and Related Questions

Purely quantitative considerations, although important in the psychophysical methods, are not the only ones that matter. With human response-data the issues are at the same time complicated and clarified by the additional variable of communicable human experience on the part of the subject being tested. This immediately raises the question of standardization of procedures, a principle which may be applied to the use and meaning of language as well as to the operational procedures of the psychophysical methods. Nearly 30 years ago Fernberger (1930), in one of many methodological studies of the psychophysical methods, stated since that the objective parts of most psychophysical procedures

have been standardized there is now a need for the standardization of the more difficult and more elusive subjective phases. Or, to take another example, Helson (1938, p. 446), after having described a series of studies in which the subject was required to recognize and report upon the appearances of coloured surfaces under different conditions of illumination, stressed that the consistency of the results obtained owed much to the preliminary training of the subject. He went on to express the belief that both stimulus conditions and the subject must be 'standardized' if reproducible results are to be obtained and scientific hypotheses formulated. More recently, in an unpublished observation to the 1950 Symposium on 'Subjective Assessment' Oldfield noted that existing psychophysical procedures 'have induced in the subject the tendency to make certain standard and consistent judgments by a form of verbal instruction'. As argued in an earlier article in this series standardization of procedures may be claimed to be an essential step towards objectivity, such as has been obtained with so many purely instrumental techniques. Any reservations which seem to lie behind Oldfield's comment would seem to refer primarily to the fact that this standardization of subjective responses must be viewed critically so that the actual modification of what is being assessed and resulting from standardization is not *unwittingly* overlooked.

Another topic, with a protracted series of discussions behind it, may also be noted here. It seems particularly necessary to emphasize this point for those who have been trained exclusively in the exact sciences, although the issues seem far from clear to a number of psychologists. The issues concerned have been discussed under the general heading of 'stimulus error'. The task of 'the subject' in a psychophysical investigation is to state his experiences and to respond to them (in a pre-arranged and standardized way) and not to base his reactions upon what he *knows* or *believes* to be happening to the stimuli which are being varied. Of the various continua involved, the stimulus continua are at least logically distinct from the continua of experience and the response continua. Although no serious errors of interpretation may arise in specific, simple examples if these three types of data are projected, as it were, on to a single plane, this is certainly not true of more complex examples in some of which the relevant objective variables are numerous and by no means satisfactorily defined or measured. Two contrasting examples may be noted, by way of illustration. The expression of human colour responses in terms of the tri-stimulus-mixture equations, referring to the hypothetical average observer, on a chart whose dimensions are strictly those of wavelength and relative physical intensity fails to keep the sensory and the instrumental data distinct from one another. This would be very easy to achieve by using connected regions on two *separate* diagrams (mathematical topology?). However in practice little serious error results from over simplification in this example. If the relationships were less clearly defined and the points specified by those relationships subject to a greater degree of inherent uncertainty than is actually the case here, the simplified picture would be a false representation of the facts. A comparatively unexplored example of this type (which is at present being examined jointly by the Textile Department and the Department of Psychology in the University of Leeds) concerns the streakiness of knit-wear formed from blended fibres of different colours. Streakiness forms a differentiable subjective continuum; some though by no means all of the relevant instrumental variables are known and others are being sought. However, to identify streakiness with any one (or with any group) of the physical variables, or to suppose that it is the task of human observers to pass judgment upon the *physical* variables, would be to commit the 'stimulus error'.

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Award of Royal Medals

Her Majesty The Queen has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows:

To Prof. H. S. W. Massey, F.R.S., Quain professsor of physics at University College in the University of London, for his distinguished contributions to physics, and particularly for his experimental and theoretical studies of collision phenomena in gases.

To Prof. A. L. Hodgkin, F.R.S., Royal Society Research Professor, for his distinguished work on the mechanism of excitation and conduction in nerve and muscle.

New Committee on Space Research

At its recent meeting, October 2 to 6, 1958, in Washington, D.C., the International Council of Scientific Unions (ICSU) established a Committee on Space Research (COSPAR). ICSU stated that the primary purpose of COSPAR is to provide a means whereby the scientific community may use to maximum advantage the possibilities of satellites and space probes for scientific purposes, and exchange the resulting data on a co-operative basis.

On November 14 and 15, 1958, the COSPAR, as guests of the Royal Society London, held its first meeting in the Society's rooms at Burlington House, Piccadilly, London. A constitution, setting forth a charter, rules of procedure, and organization for COSPAR was drawn up for approval by ICSU. The following Executive Committee was elected:

President: Prof. H. C. van de Hulst, of the International Astronomical Union. *Vice-Presidents:* Prof. E. K. Fedorov, Corresponding Member, USSR Academy of Sciences, Moscow; Prof. W. Albert Noyes, Jr., University of Rochester, New York. *Members:* Prof. Maurice Roy, International Union of Theoretical and Applied Mechanics; Prof. H. S. W. Massey, International Union of Pure and Applied Physics.

FOOD ANALYSIS—TECHNIQUES, INTERPRETATION AND LEGAL ASPECTS

by D. Pearson, M.Sc., F.R.I.C.

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PART IX—THE DETERMINATION OF PRESERVATIVES

PRESERVATIVES

Legislation Relating to Preservatives

For the purpose of the Public Health (Preservatives, etc., in Food) Regulations 1925-1958 the term 'Preservative' means any substance which is capable of inhibiting, retarding or arresting the process of fermentation, acidification, or other decomposition of food or of masking any of the evidences of putrefaction; but does not include common salt, saltpetre, sugars, lactic acid, acetic acid or vinegar, glycerine, alcohol or potable spirits, herbs, hop extract, spices and essential oils used for flavouring purposes, or any substance added to food by the process of curing known as smoking.

The following represent the main provisions of the regulations from the point of view of the analyst:

(*a*) Maxima are stated in The First Schedule for sulphur dioxide or benzoic acid in certain named foods. Ingredients of non-scheduled foods may however contain the preservative normally permitted up to the stated limit (in the examination of finished products, the preservative should be calculated on the scheduled ingredient, e.g. sulphur dioxide in table jellies is calculated back to the gelatine).

(*b*) The preservative is to be calculated by weight as sulphur dioxide or benzoic acid but the actual preservative may be added as sulphite or benzoate.

(*c*) Nitrites are permitted in cured meats.

(*d*) The Second Schedule requires that with certain foods (e.g. sausages, coffee extract, pickles and sauces) the presence of preservatives should be declared.

(*e*) Recent amendments to the regulations state maxima for diphenyl and orthophenylphenol in citrus fruit.

Suggestions have been made in recent years in relation to other possible changes in the regulations (British Food Journal, 1956, p. 73; Analyst, 1951, **76**, 276).

Methods Employed for the Examination of Preservatives in Foods

General Note.—Official laboratories usually make a qualitative 'sorting' test, which is followed by a quantitative determination on those foods which have given positive results. In industry, quantitative determinations can often be applied immediately as the presence of the preservative is usually known beforehand.

Sulphur Dioxide.—Sulphur dioxide is the most commonly used of the permitted food preservatives. Apart from its preservative effect, however, it is used for improving the appearance of the food (bleaching), for cleaning casks and for giving protection against attack by insects. Sulphur dioxide may be incorporated into the food in many forms, e.g. burning sulphur fumes, alkaline or acid salts of sulphurous acid, liquid sulphur dioxide (Joslyn and Braverman, 1954, p. 129 to 133). It appears to be more effective against moulds than yeasts and it seems possible that it unfortunately tends to 'inactivate' some vitamins (Ingram, Ottaway and Coppock, 1956).

From microbiological work carried out mainly on fruit juices and wines it is apparent that only a small fraction of the total sulphurous acid present is active against micro-organisms. Thus from the preservation point of view the sulphurous acid present can be considered as being present in three different forms—(*a*) the bound form in which it is combined with sugars, aldehydes, etc. to form bisulphite compounds, (*b*) the dissociated fraction of the unbound acid and (*c*) the undissociated fraction of the unbound acid. It appears that it is only the very small proportion of the latter form (*c*) which has any really effective power as a preservative. It is possible however to increase the proportion of this active non-ionized portion (*see* Joslyn and Braverman, 1954) by lowering the pH. This effect of the pH on dissociation and the related anti-microbial effects with numerous acids is discussed by Ingram *et al.* (1956).

For the *qualitative detection* of sulphur dioxide the most reliable method is (in the opinion of the writer) the modified method devised by Parkes (1926), in which a conical flask is fitted with a small U-bubbler of a similar type to those used for 'closing' Kipp's apparatus and also as fermentation locks. The sulphur dioxide is liberated from the food by boiling with acid in an inert atmosphere (maintained by the addition of marble to the acid) and the gas is allowed to bubble through a reagent containing iodine and barium chloride contained in the U-bubbler. In the presence of sulphur dioxide the iodine is decolorized and a precipitate of barium sulphate settles in the tube. The formation of a mere turbidity is inconclusive as it may be due to traces of preservative or to other volatile compounds.

The sulphur dioxide should be determined as soon as possible after receiving the sample, as the amount of preservative often rapidly diminishes. Most of the methods which have been proposed for the determination consist essentially of the distillation of the

sulphur dioxide from acid followed by absorption of the gas by an oxidizing agent, which converts it to sulphate. Monier-Williams (1927a) recommended, for what is usually referred to as the 'official' method (A.O.A.C., 1955, p. 507; B.P., 1958; B.S.757:1944 for gelatine) the oxidation of the distillate in U-tubes containing hydrogen peroxide followed by titration of the sulphuric acid so formed with dilute standard alkali using bromphenol blue as indicator. Shipton (1954) has made a useful study of the various stages of the A.O.A.C. procedure in order to make it more applicable for routine use. His main recommendations are (*a*) the use of a less cumbersome vertical apparatus with ground glass joints, (*b*) the replacement of gas by electrical heating (*see also* Nichols and Reed, 1932), (*c*) the use of a regulated flow of nitrogen as inert gas because the presence of carbon dioxide interferes with the end-point (*see also* Thompson and Toy, 1945), (*d*) the abolition of the necessity of using previously boiled water (*see also* Nichols and Reed, 1932), (*e*) the use of unneutralized hydrogen peroxide which can be corrected for by means of a blank titration (*see also* Nissen and Peterson, 1943 and Morris, 1947) and (*f*) the omission of the heating of the condensers at the end of the refluxing (*see also* Thompson and Toy, 1945). Shipton (1954) claims excellent agreement between his method and the A.O.A.C. procedure in spite of the saving in time.

Titration of the sulphur dioxide with iodine as it distils over produces rapid results, but for consistent results it is important to follow an exact procedure such as that proposed by the F.M.F. and the Manufacturing Confectioners' Alliance (Analyst, 1928, **53**, 118). Bromine water is less commonly used. For borderline or doubtful results it is advisable to add hydrochloric acid and barium chloride to the titrated liquids so that a gravimetric comparison may be made. Where organic sulphur compounds are present in any quantity, e.g. onion, mustard, some pickles and sauces, the Monier-Williams (1927a) procedure is more specific but the gravimetric precipitate must be obtained without heat.

The distillation methods mentioned above determine the total sulphurous acid, i.e. both the 'free' and 'combined' forms. With liquids, however, it is more convenient for routine factory checks to titrate directly with standard dilute iodine solution and by varying the conditions and reagents it is also possible to assess both the 'free' and the 'total' sulphite present (*see* Gehman and Osman, 1954 and Joslyn and Braverman, 1954). The results obtained are dependent on pH and other factors, and because of the rather indefinite starch end-point such methods are less reliable than the distillation procedures. An electrometric titration method has been suggested (Ingram, 1947; Ingram and Vas, 1950).

A field test has been described by Chatt and Hinton (1955) in which an exact quantity of liberated iodine (produced from acidified iodide-iodate tablets) is 'titrated' with a 50 per cent alkaline solution of preserved fruit (intended for jam manufacture) and the sulphur dioxide figure can be obtained by reference to a table given in the paper.

A few workers have devised colorimetric methods for determining sulphur dioxide. The fuchsin-formaldehyde procedure has been discussed by Joslyn (1955) and he gives comparisons of the results obtained with wines with those obtained using the direct iodine method. Brenner, Owades and Fazio (1956) have proposed another colorimetric method for beer, and claim that this gives lower and more accurate results than those obtained by the Monier-Williams method.

Benzoic Acid.—Benzoic acid is of lesser importance than sulphur dioxide, because it is only permitted in a few foods, particularly soft drinks, fruit juices, coffee extract, pickles and sauces. The preservative is usually incorporated as sodium benzoate solution as the acid itself is much less soluble in water. The acid acts against both yeasts and moulds, the effective agent being the free acid (Ingram *et al.*, 1956).

For the *qualitative detection* of benzoic acid the amount present in foods is usually insufficient to give a definite buff precipitate with ferric chloride and it is advisable to apply a modification of the more sensitive Mohler's test to the ether extracted acid (*see* A.O.A.C., 1955, p. 487). Alternatively paper chromatography may be employed for the detection of benzoic acid and other related preservative acids (Parkinson, 1952: *see also* Anal.Abs., 1956, **3**, No. 548; 1958, **5**, No. 1373; 1958, **5**, No. 1990).

For the *quantitative* estimation it is possible with non-viscous foods to extract the benzoic acid directly with ether from a slightly acidified solution which has been saturated with salt. If saccharin is present the extraction should be carried out at pH 4·0 (Garratt, 1955, p. 426). The acid is purified by shaking the bulked ether extracts with dilute sodium hydroxide solution followed by treatment at 60°C. of the alkaline solution with permanganate to remove interfering acids. Excess permanganate can then be removed with sulphur dioxide and the acid re-extracted with ether after acidifying the aqueous solution. The solvent must be removed with not more than gentle heat prior to the residue being dried and weighed.

For most viscous foods, e.g. sauces and coffee extracts it is advisable to steam distil the acid from phosphoric acid as recommended by Monier-Williams (1927b). In this method the extracted acid is sublimed at 160°C. in a test-tube. Monier-Williams recommended that the part of the tube containing the sublimed crystals should be cut off, but it is possible to obtain a tube divided in two, the parts being connected by a ground glass joint.

Whichever extraction method is used it is advisable (after weighing) to dissolve the benzoic acid in a suitable solvent and confirm the result by titration, colorimetry or spectrophotometry. Nicholls (1928) suggested a modification of Jonescu's test in which the benzoic acid is partially converted by hydrogen peroxide to salicylic acid, which gives the usual violet colour with

ferric chloride (*see also* Edwards, Nanji and Hassan, 1937).

Illing (1932) and Jones (1925) have proposed methods for the colorimetric determination of the purified benzoic acid which are based on Mohler's nitration test. Spanyar, Kevei and Kiszel (1958) have recently proposed another colorimetric nitration method in which the resultant 3:5 dinitrobenzoic acid is mixed with sodium hydroxide in acetone-alcohol solution to form a stable blue-violet colour.

For the estimation of minute amounts (less than 10 p.p.m. in solution) the acid is best estimated in ether solution using the spectrophotometer (absorption peak 227mμ) (Englis *et al.*, 1955).

Salicylic Acid.—Salicylic acid was extensively used as a food preservative until it was prohibited by the Preservatives Regulations. It can be extracted by the direct method used for benzoic acid, but alkaline permanganate treatment destroys it. Salicylate can be detected by the violet coloration produced with ferric chloride or by employing Jorissen's test (A.O.A.C., 1955, p. 506). Neither method is considered to be completely specific for salicylic acid, but both have been modified for quantitative estimations (*see* Nicholls, 1928 and Edwards, Nanji and Hassan, 1937). Englis *et al.* (1955) have proposed a spectrophotometric method (absorption peak 236mμ with a secondary maximum near 306 mμ) employing ether as solvent.

p-Hydroxybenzoic Acid.—The sodium salt and the methyl, ethyl and propyl esters of p-hydroxybenzoic acid are used as food preservatives on the continent, but are prohibited in Britain.

The acid gives a rose-red colour with Millon's reagent, and this reaction can be applied for its detection and determination. It is, however, non-specific (Allport, 1951, p. 142). The test must be applied to the neutral ammonium salt. As the preservative may be present as an ester it must first be extracted with ether. After removing the solvent, the preservative is hydrolyzed with alcoholic potash and converted to the neutral ammonium salt before applying Millon's reagent (Allport, 1951) and comparing the colour with standards. Some chromatographic methods have also been devised for p-hydroxybenzoic acid (Parkinson, 1952; Anal.Abs., 1956, **3**, No. 1373).

Boric Acid.—Boric acid is now prohibited as a preservative for foodstuffs. For its detection the turmeric test is the most reliable. It is best carried out by making the food alkaline and then applying the test after ashing. The sensitivity is increased considerably by adding a few drops of oxalic acid solution (*see* Monier-Williams, 1950). Robinson (1939) has modified the test so that it can be employed for colorimetric estimations of traces of borate.

The more conventional quantitative methods conclude with a titration. The extracted borate is first neutralized to methyl red. Then mannitol or glycerin is added to convert the boric acid to a relatively strong monobasic acid, which can be titrated to phenolphthalein (Scott-Dodd, 1929/30; Garratt, 1955, p. 92). Prior to the titration the methods employed for the preliminary treatment involve either simple extraction of the aqueous phase of a food such as butter or margarine (Davis and Macdonald, 1953), or ashing with alkali (Anal., 1923, **48**, 416; A.O.A.C. 1955; p. 488, Alcock, 1937). In Thomson's lengthy method any phosphate present is precipitated as the calcium salt and Alcock distils the preservative as methyl borate in a continuous distillation apparatus (*see* discussion by Monier-Williams, 1950).

More recently absorptiometric and spectrophotometric methods have been proposed for determining boric acid employing reagents such as carmine (Hatcher and Wilcox, 1950) and quinalizarin (Ripley-Duggan, 1953). Both methods have the practical disadvantage that the colorimetric reaction has to be carried out in almost concentrated sulphuric acid.

Formaldehyde.—Although legally its use is entirely prohibited, formalin, being a powerful preservative is probably still used occasionally (e.g. in milk). It can be detected by layering Gerber sulphuric acid containing a trace of ferric chloride below the milk. In the presence of formaldehyde a violet coloration appears between the layers (Hehner's test). The milk itself supplies the tryptophane which must be present. In testing other materials milk or a source of tryptophane must therefore be added to the food or its steam distillate. Other qualitative tests which may be applied are Jorissen's phloroglucinol test and Schryver's (1909) test employing phenylhydrazine and ferricyanide.

The classical quantitative methods were proposed by Shrewsbury and Knapp (1909) and Schryver (1909). More recent colorimetric methods are those employing chromotropic acid (Boyd and Logan, 1942; Lee, 1956) and codeine (Godfrain *et al.* 1958). Low results are commonly due to loss from the food or inefficient steam distillation which encourages polymerization. The presence of formaldehyde in a food is, however, sufficient to condemn it.

Hexamine, which is permitted to be used as a preservative in some continental countries is converted to formaldehyde on distillation from acid solution. The resultant formaldehyde can then be estimated by the chromotropic acid method. Methods for *formic acid* are given in the standard text-books (Nicholls, 1952, p. 406; Cox, 1950, p. 109; A.O.A.C., 1955, p. 493).

Nitrites and Nitrates.—The presence of up to 200 p.p.m. of nitrite (calculated as $NaNO_2$) is permitted in many forms of cured meat. It is usually detected and estimated by the Griess-Ilosvay (1889) method which depends on diazotization of sulphanilic acid by nitrous acid and the coupling of the resultant compound with α-naphthylamine to form an azo dye. Extracts of cured meat should preferably be treated with clearing agent (e.g. dialyzed iron, mercuric chloride) and filtered prior to the addition of the reagents. The red colour reaches its maximum intensity after 15 minutes when the measurement can be conveniently made using the

B.D.H. Nessleriser. Alternative methods have been proposed by Giblin and Chapman (1936) and Shinn (1941).

Nitrates can be estimated by the meta-xylenol method of McVey (1935) (*see also* Barnes, 1950).

Anti-Fungal Agents

Diphenyl and Ortho-phenylphenol.—The presence of these substances or mixtures of them are allowed in citrus fruits up to certain limits (S.I. 1958. No. 1319). Methods for diphenyl have been proposed by Tomkins and Isherwood (1945) and Cox (1945). Diphenyl in cyclohexane shows an absorption maximum at 251 mμ (E 1% 1 cm. 1200). Both substances can be steam distilled from the food. If both are present and the fruit is first steam distilled from alkali, the phenol is held back and the diphenyl distils over. Then by continuing the steam distillation after acidification of the fruit the o-phenylphenol comes over and can be estimated separately (absorption maximum at 245 Mμ).

Inaccuracies in the proposed methods are largely due to the presence of orange oil (*see* Steyn and Rosselet, 1949 and Hoeke and Cats, 1958). Baxter (1957) has reviewed the methods which have been proposed for diphenyl in citrus products and suggests that a permanganate oxidation method and the modified chromato-strip-spectral method of Stanley, Vannier and Gentili (1957) are the most promising (*see also* J.A.O.A.C., 1957, **40,** 238).

Thiourea.—M.O.F. Circular MF 2/54 states that the presence in oranges of the rot and mould suppressant thiourea is a contravention of the Preservatives Regulations.

Both qualitative and quantitative methods for thiourea are described in the A.O.A.C. (1955, p. 509). The modified Grote reagent (pentacyanoammonioferroate test) employed produces with thiourea a blue colour which is measured at 610 mμ (*see also* Hoeke and Cats, 1958).

Sorbic Acid.—In the U.S.A., the mould and yeast inhibitor sorbic acid is permitted to be present in cakes up to a maximum of 0·3 per cent. For its estimation, sorbic acid can be steam distilled and extracted as in the Monier-Williams' (1927b) procedure, but the treatment with permanganate must be omitted. The sorbic acid is removed from its ethereal solution with sodium hydroxide and then the optical density at 255 mμ of the aqueous solution is measured after adjustment of pH to 5·9 (Melnick and Luckmann, 1954; Luckmann and Melnick, 1955 and Alderton and Lewis, 1958).

Eeckhaut (1956) has devised a method for the detection of sorbic acid (after distillation) based on the violet coloration with ferric chloride combined with oxidation to acetaldehyde on addition of permanganate. The latter reaction is not given by salicylic acid.

Acetic and Propionic Acids.—For the determination of these acids reference should be made to McRoberts (1951) and A.O.A.C. (1955, p. 224).

Miscellaneous Preservatives

Hypochlorites.—At least 0·7 per cent of sodium chlorate must be present in the stock solutions of hypochlorite which are used in the dairy industry for sterilization of equipment. In Wright and Anderson's (1938) method for milk using diluted sulphuric acid containing a trace of stannous chloride, the chlorate present gives a greenish-yellow fluorescence in ultra-violet light. Another method based on Korenman's indigo-carmine reaction has been proposed by Hunt (1939).

Antioxidants.—The Antioxidant in Food Regulations, 1958 (S.I. 1958, No. 1454) permit the presence up to certain limits of certain antioxidants (e.g. gallates, butylated hydroxyanisole, butylated hydroxytoluene) in oils, butter for manufacturing purposes and essential oils. The estimation of antioxidants in 'pure' oils is relatively simple (Mahon and Chapman, 1951; Anglin, Mahon and Chapman, 1956), but difficulties arise with extracted oils from 'compound' foods. In recent years, however, much progress has been made in methods designed to detect and separate series of antioxidants by paper chromatography (Gander, 1956; Kawata and Hosogai, 1958; Mitchell, 1957). In a second paper Gander (1957) however gives a warning that some oils contain natural antioxidants which have Rf values and give colour reactions similar to those of added antioxidants.

Antibiotics.—The spectacular success of antibiotics in combating disease has led to investigation of their possible use for food preservation. The health authorities are likely to resist the use of antibiotics in food as it is considered that it will set up a dangerous resistance to therapy when used medically (Food Sci.Abs., 1956, **28,** 121). The amounts used are extremely small and bio-assay must be employed. The extractant has to be chosen in relation to the particular food and organism, and for each antibiotic there is an assay organism which is considered to be the most efficient for producing reproducible results (e.g. *B.cereus* for chlortetracycline). A 'pad-plate' assay technique is commonly employed (Grady and Williams, 1953; Broquist and Kohler, 1953/4).

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G.E.C. 7 kW H.F. induction furnace installed at King's College, London, for melting small quantities of metal.

Casting an implant after melting the metal in the G.E.C. 7 kW H.F. induction furnace at King's College, London.

INDUCTION HEATING AIDS STUDY OF BIOMECHANICS

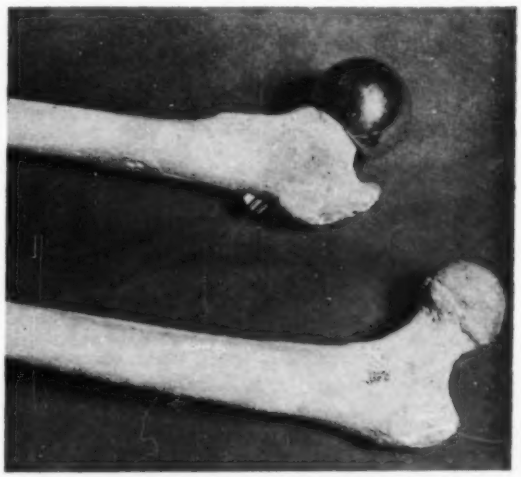
THE introduction of antibiotics and the development of anaesthetics have made possible the extensive surgery necessary to replace diseased parts of the bone in the human body. Operations of this nature can mean the saving of human limbs, but their success is dependent upon a true appraisal of the conditions the replacement must withstand and a judicious selection of the replacement material.

To further the study of biomechanics at the University of London's Faculty of Engineering a high frequency induction melting equipment designed and supplied by The General Electric Co., Ltd., has been installed at King's College. The induction furnace meets a need for a convenient method of melting, with minimum contamination, small quantities of metals both for fabricating experimental parts, and for producing alloys to be tested for mechanical properties and biological compatibilities.

Considerable progress has already been made in the surgical treatment of diseases of leg bones using metal implants made of cobalt-chrome-molybdenum alloy. The induction heating equipment will melt 10 lb. of cobalt-chrome-molybdenum alloy in 20 minutes. However, the high cost of this alloy prohibits its everyday use and the search continues for a cheaper but equally satisfactory material.

Because of the complex shapes involved, metal implants are produced by casting and moulds are made by the lost wax process. The shape of the master form can be reproduced in P.V.C. which is then used to cast a wax replica. The mould is formed round the wax which is then melted and run out.

The G.E.C. induction furnace used to melt the metal incorporates a valve-operated generator giving an output of 7 kW at a frequency of 500 kc/s. The generator is housed in a steel dust-proof cabinet with a filtered air intake for cooling the interior. The radio circuits are well protected by replays and fuses and removable panels and doors are fitted with safety interlocks. The high frequency power is supplied to a



Part of the femur, showing how the head which is subject to arthritis can be replaced with a metal implant.

heating inductor mounted in a sheet metal cabinet at the front of the generator.

The metal is placed in a refractory crucible inserted into the cabinet through a hole in the top heat-resisting cover. The crucible stands on a ram used to move it in and out of the heating inductor, and to give control of the high frequency power by varying the coupling between the charge and the coil. The height of the ram is adjusted with a lever which projects through the front of the furnace cabinet and moves through a notched gate. When a melt is in progress the mouth of the furnace is covered with a lid and a safety switch ensures that the high frequency power cannot be switched on unless the lid is in position. A small hole in the furnace lid enables the progress of a melt to be observed.

Systemic Fungicides

Prof. R. L. Wain presented a notable lecture to the London Section, Royal Institute of Chemistry, at Kings College on October 15 when Dr. C. C. Hall presided.

The lecture, which was excellently illustrated with slides and covered a somewhat wider field than indicated by the title, dealt with certain aspects of the chemical control of plant diseases. Following a brief historical account of the copper fungicides, such as Bordeaux mixture, recent work on their mode of action was considered. Research by the lecturer and others had shown that the insoluble Bordeaux deposit on the leaf was rendered lethal to fungal spores by action of exudates from the spores themselves. Soluble copper so produced was shown to be in the form of complexes with amino and hydroxy acids. These complexes are capable of yielding the cupric ion by dissociation which could then be accumulated by the spores until a toxic concentration was reached. Such studies on mode of action are invaluable in relation to fungicidal usage.

The other important group of inorganic fungicides—those based on sulphur—were also briefly considered.

The remainder of the lecture was concerned with recent developments in the field of systemic fungicides, i.e. chemicals which are capable of conferring protection against diseases when present within plant tissues. Previous work in this field was briefly reviewed and an account of the two-sided approach to the problem of systemic fungicidal action being adopted by Prof. Wain and his co-workers was given. One such approach arose logically from his studies on chemical structure in relation to mode of action of plant growth substances. These investigations led him to study a group of aryloxy and arylthic acids which, although freely absorbed by and translocated in plants, were nevertheless non-phytitoxic and did not produce undesirable growth effects. Some of these compounds, however, while possessing significant systemic fungicidal activity within the plant were found to be poor fungicides *per se* thus indicating that chemical changes occurring within the tissues are important in systemic activity.

The second approach to systemic fungicidal action adopted by Prof. Wain stemmed from a consideration of natural disease resistance in plants. He pointed out that in nature such resistance was very widespread and while this could often be accounted for by morphological characteristics of the plant, such as a thick or waxy leaf epidermis, there was evidence that in many cases natural resistance had a chemical basis. Fungicidal compounds which might play such a protective role have been found in a number of plants, for example, Virtanen has isolated such a compound from rye seedlings and another from maize and rye plants. Both these compounds, which have been identified, possess fungicidal properties. A further example was the discovery by Prof. Wain and his colleagues of an as yet unidentified antibiotic with strong antifungal properties which is present in the stem and root tissues of broad beans (*Vicia faba*).

The Toxic Hazard and Insecticidal Aerosols

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AUTHORS' NOTE.—We shall be commenting on the annotation in the B.M.J., p. 1522, Dec. 20, 1958, in the next issue.

Food Analysis

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1959 PHYSICAL SOCIETY EXHIBITION

The Physical Society's 1959 Exhibition will be held from January 19 to 22, in the Old and New Halls of the Royal Horticultural Society, Westminster. This Exhibition, which is the 43rd of the series, will include 153 exhibitors and will represent a cross section of the latest developments in British physics.

AS IS well known, it is the policy of the Physical Society to show as many new instruments and techniques as possible, and it is hoped that the Exhibition of 1959 will maintain and exceed its previous high standards. A large number of universities, hospital physics departments and research organizations are again participating, thus assuring a high proportion of purely research exhibits. As is usual, exhibits will show the trend of instrumentation in industry, research and teaching for the next 12 months.

Visitors to the Exhibition will be most interested in the selection of instruments from Swedish universities and research organizations, which is being shown this year by invitation of the Council of the Physical Society. This Swedish exhibit is under the auspices of the Royal Swedish Academy of Engineering Sciences.

The scope of the Exhibition is very wide and includes such items as fully developed instruments for the tracking of artificial earth satellites. Another recent advance in technology—the automatic factory with the requisite complex control of machine tools—is well represented by the various forms of diffraction gratings and their applications to the accurate positioning of tools. Such new introductions as the Maser, for microwave techniques, are shown for the first time this year.

Exhibits to be shown by the **Admiralty Research Establishments** (Stand 37) will come from the Admiralty Research Laboratory, the Signal and Radar Establishment and the Services Electronics Research Laboratory.

The Admiralty Research Laboratory will be exhibiting an automatic strain gauge balance equipment which was designed for use with resistance strain gauges for force and pressure measurements in hydrodynamic research. A film asscssor will be shown which provides a semi-automatic means of measuring accurately on photographic records positional co-ordinates and orientation. It has been designed primarily to produce information on standard 5 hole teleprinter tape (or punched card) for feeding into a high speed computer. Although originally for analysis of cine records it has the application to the analysis of kine-theodolite records and also continues trace records. Miniature radio-active contamination meters developed for ship-borne use in case of an atomic explosion, using transistors and with self-contained power supplies will also be shown. The Admiralty Signal and Radar Establishment will be showing a sealed ammonia filled resonant cavity for use as a portable microwave frequency standard; a constant beamwidth S-band horn type aerial; a microwave artificial dielectric lens manufactured from a newly developed low loss artificial dielectric; and a metre-wave radar aerial. The Services Electronics Research Laboratory have developed a X-band C.W. power travelling wave tube which uses a 'clover-leaf' type of structure and combines good power handling capacity with moderate band width. A section model will be shown illustrating the construction, together with typical performance curves.

A parametric amplifier for the microwave region will be shown as a working exhibit together with examples of the solid state devices used for obtaining the reactance variation.

Among the new instruments to be shown by **Advance Components Ltd.** (Stand 31) will be the Advac valve voltage meter Type 77, the LF. signal generator Type 81, the FM/AM. signal generator Type 60, wide band attenuators Types A75, A76, A79 and A83, and high current stabilized DC voltage supply units.

Four instruments only will be shown by **Airmec Ltd.** (Stand 40). These are the millivoltmeter Type 264, a mains operated instrument designed for the measurement of small a.f. or r.f. voltages over a wide range of frequencies; a display oscilloscope Type 279 employing a 17 in. rectangular long afterglow, cathode ray tube associated with a four beam facility for the study of waveforms, and the relationship between waveforms, from as many as four sources a proximity detector Type N266—a capacity switch which operates a relay system when any substance is brought within a predetermined distance from the sensing probe; and a transistor power supply Type 270—a small compact unit which may be used as an ancillary equipment or as an installed item in transistorized instruments. Concurrently with the Physical Society Exhibition, the company will be giving a private exhibition at the Napier Hall in Hyde Place, Vincent Square, at which the full range of their equipment will be shown.

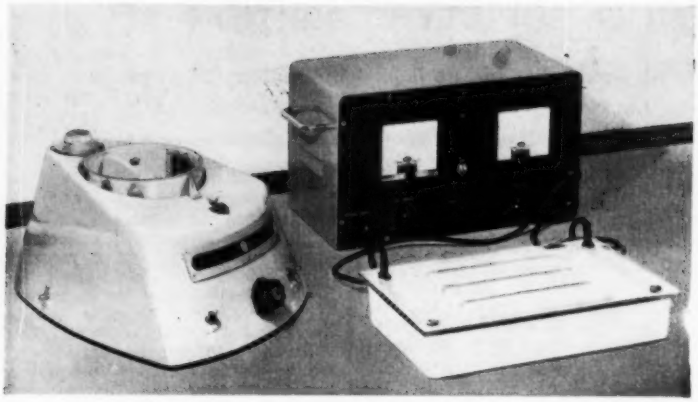
The Surface Physics Section of the Research Laboratory of **Associated Electrical Industries Ltd.** (Stand 146) will be showing the Rodolite (a plane reflection grating, 2 in. in diameter, ruled with a system of concentric circles), the straight line interferometer (an instrument which has been used for checking straight edges and precision surfaces such as the sealing rings of an axial flow compressor), and a double ended alignment device. The Solid State Physics Section will be exhibiting crystal pulling equipment which has been designed to eliminate the conventional heated crucible for holding the melt.

Among the items of equipment to be shown by **Avo Ltd.** (Stand 131) will be the transistor analyzer, a battery operated transistor tester suitable for testing small and medium n-p-n or p-n-p transistors either *in situ* or removed from associated apparatus; various types of signal generators; a remote indicator dose ratemeter, designed to meet special requirements where it would be dangerous for an operator to expose himself directly to radiation hazards; the Radiac survey meter Mark III for use in the

VISIT THE U.T.P. STAND

Enquiries concerning their publications will be welcomed by United Trade Press, Ltd., at Stand No. 73. Among the journals and publications to be displayed will be: *Laboratory Practice, Instrument Practice Automation and Electronics, Automation and Automatic Equipment News,* **'Course in Industrial Instrument Technology', 'Laboratory Control of Dairy Plant', and 'The Industrial Application of pH Measurement and Control'.**

The Avo transistor analyser.



B.T.L. equipment for electrophoresis.

detection and measurement of gamma radiation; and a photo transistor relay meter.

An entirely new range of apparatus for paper chromatography, incorporating a wide variety of techniques within the minimum number of basic assemblies, will be shown by **Baird & Tatlock (London) Ltd.** (Stand 98). This will include strip tanks, multi-sheet tanks, two dimensional sheet tanks, stoneware tanks, all glass spray, drying oven and desalting apparatus. For column chromatography, columns will be shown together with the B.T.L. fraction collector—the finalized production version of the continuous belt concept which aroused such great interest when first introduced last year. For electrophoresis, the company will be showing their horizontal tank, the constant current/constant voltage stabilized power unit and densitometer. All these items will be seen in their production form; certain other items in the range are still under development and of these the prototypes of the gas chromatograph and centrifugal chromatograph will be on view.

Two of the new low stereoscopic magnifiers for laboratory and workshop use will be exhibited by **C. Baker of Holborn Ltd.** (Stand 91). Among other exhibits will be the Trilux microscope condenser, now in production in a modified form, the use of which enables light field, dark field and phase contrast to be done with one condenser and a rapid changeover to be made from one illumination to another; the Simplux illuminator—an inexpensive illuminator which can be fitted to student microscopes in place of the mirror, and which provides sufficient light for oil immersion work; the 3 min. polarizing microscope which has been redesigned and will be shown for the first time in its new form; the interference microscope shown with the cell compressor designed by Dr. Ambrose of the Chester Beatty Research Institute, and a Series 4 research microscope, equipped with objectives using a new design of mount.

A range of their 'Atomat' equipment will be shown by the **Baldwin Instrument Co., Ltd.** (Stand 38). These will include the backscatter thickness gauge, the electronics of which are identical to those used in the standard transmission gauge; fast responding 'Atomat', applicable to the automatic thickness control of products produced on high speed machines such as metal foil rolling mills; nucleonic thickness gauge with automatic standardization, and a transverse profiler—a bench version of the beta ray substance gauge intended primarily for use in the paper industry for the measurement of level.

Other exhibits on this stand will include a transmission densitometer and reflection densitometer both with colour filters, line densitometer with filters, a flame photometer, designed for the quick and accurate determination of calcium in blood sera, and protection electrometers and pocket dosemeters.

In many scientific fields information is conveyed by means of electrical signals which are frequently contaminated by noise or the energy distribution covers too wide a frequency band. In such cases filtering may be desirable and **Barr & Stroud Ltd.** (Stand 61) will be showing several electric wave filters to illustrate some applications of modern methods. Two new types of optical filter will also be shown:

1. A circular graded spectrum filter covering the approximate range 4000 to 7000A.

2. A range of interference filters for use in the infra-red up to a limit of approximately 5μ.

A further exhibit will be a modified form of the Type VL1 monochromator which incorporates a replica reflection grating in its second stage, with a suitable fore prism in the first stage to eliminate overlapping orders. The company will also be showing an automatic scanner for nuclear research emulsions and a power-operated photonymograph.

The Multimax stereoscopic binocular microscope, exhibited last year by **R. & J. Beck Ltd.** (Stand 93), is now available with interchangeable stands, a large table support being shown. The Optomax research binocular microscope will also be shown equipped with a universal vertical illuminator. The alternative lens

The Multimax stereoscopic binocular microscope. *R. & J. Beck Ltd.*

systems incorporated in the unit provide for vertical illumination by either the light-field or dark-field techniques. In order to satisfy modern requirements, an integral illuminator, fitting interchangeably with the substage mirror of the No. 47 range of microscopes is introduced. Other exhibits include a vertical illuminator, a Versalite microscope lamp, a simple micrometer microscope, and a Bier contact lens spherometer; this adaptation of a standard microscope unit enables the curvature of either positive or negative surfaces not exceeding 10 mm. radius to be measured to an accuracy of ·01 mm.

The Department of Anaesthetics of Bristol University (Stand 58) will be showing a differential capacitance manometer designed to be part of a pneumotachometer which is not yet finished, and which has had considerable use for finger plethysmography. The transducer consists of a stressed beryllium copper diaphragm 0·002 in. thick and 1·5 in. in diameter between two brass plates. The output of the apparatus is registered on a built-in valve voltmeter and can also be connected to a standard ink-writing device. A demonstration will be given. Another exhibit will comprise a modification of the Grey Walter toposcope for single channel electro-encephalographic display using a standard 2-channel C.R.O. and electro-encephalographic amplifier. This demonstrates inherent rhythmicity in the E.E.G. output over a 10-second period, and the time relationship of the E.E.G. rhythm to any stimulus. A strain gauge for physiological use, consisting of a thin rubber tube filled with aqueous collordal graphite, will also be demonstrated.

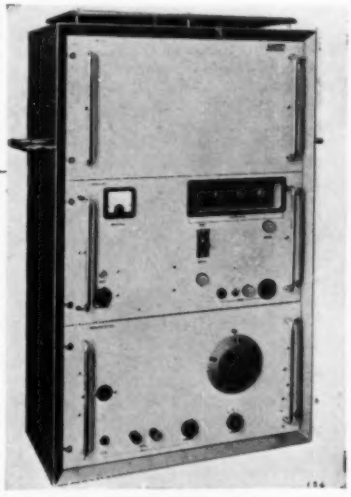
Many developments in the field of electronic test equipment will be shown by **British Physical Laboratories** (Stand 28). Among these are a tinplate thickness meter, a 100 kc/s component comparator, a digital voltmeter, a wide band amplifier, a Universal impedance bridge, and a resistance voltage co-efficient measuring set.

Work at the **British Scientific Instrument Research Association** has been directed towards a knowledge and control of the structure in the initial stages of the growth of thin films. Some of the apparatus to be exhibited (Stand 53) has been used in connection with this project and includes: apparatus for measuring the interfacial energy between condensed atoms and a substrate; apparatus for measuring the difference in binding energies between gold in the aggregated and non-aggregated states; apparatus for observing the effect of sunface conditions on the electrical resistance of gold films. Some new applications of pneumatics to instruments will also be exhibited.

The Research Laboratory of the **British Thomson-Houston Co., Ltd.** (Stand 49) will be demonstrating a range of equipments and devices. Among these may be mentioned the electrostatic dust monitor which demonstrates a method of measuring dust concentration in a gas stream; the admittance plotter, designed to display automatically, in a few seconds, the admittance of waveguide components over a broad frequency band; the superheterodyne centimetre spectrometer, intended primarily for the analysis of the spectra of pulsed oscillators, by displaying on a cathode ray tube the frequency distribution of the R.F. power; and the I.F. noise generator —a unit capable of generating 'white' noise over the normal range of I.F. frequencies. Experimental versions of silicon controlled rectifiers will be demonstrated and recent developments in silicon transistors will be exhibited.

The **Cambridge Instrument Co., Ltd.** (Stand 106) will be demonstrating a Transrite cardiograph Mk.II; this is the remodelled production version of the prototype shown last year. A new item is the automatic chart analyzer which automatically 'samples' a recorder chart at intervals of one millimeter, giving results of much greater statistical significance. Other exhibits on this stand will include mains units with intrinsically safe output, an electrochemical dissolved oxygen analyzer, Mk.III, and a general purpose polarograph—a new item which is very suitable for educational use.

Two new oscilloscopes will be displayed by **Cawkell Research & Electronics Ltd.** (Stand 16). The two-channel oscilloscope type TC1 uses a double-gun cathode ray tube for the display of two different signals. A common time-base generator is employed but separate amplifiers are fitted. The transient storage oscilloscope type SO1 is designed for the visual study of transient phenomena. The E702 has an image-storage system which enables the user to retain a single signal for examination for up to ten minutes. The non-destructive testing equipment exhibited will include the density gauge type DG1. This is a transistorized portable unit for measuring the density of substances *in situ*. A new model of the LDA damping constant meter has been produced. Particular modifications provide for measurements at lower (down to 50 c/s) and higher (up to 50 Kc/s) frequencies, for novel methods of excitation of the specimen and for simpler operation.



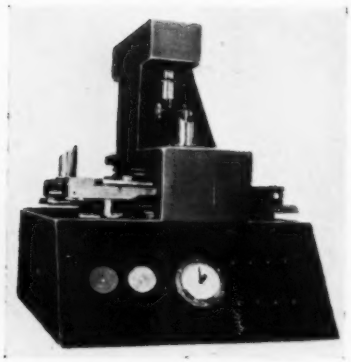
The Cawkell damping constant meter.

The Cossor laboratory high-gain l.f. amplifier.

Two items will be exhibited by **C.N.S. Instruments Ltd.** (Stand 36): Mechanical Rotary Analogue to Digital Converter: In this device the analogue movement is applied to a shaft carrying a disc which is opposed to suitably positioned micro switches. When at rest the disc and micro switches are brought together causing the operation of the appropriate micro switches. These are in turn connected to the solenoids of an electric typewriter.

Eddy Current Tube Tester for Non-Ferrous Metals: This equipment is designed to locate defects in non-ferrous metal tubes. High frequency search coils, either external or internal, are balanced against a standard section of the tube and then passed through or around the tube to be tested. When a fault is located both audible and visual alarm signals are given.

The amplifiers being exhibited by **Cossor Instruments Ltd.** (Stand 22) include a laboratory high-gain l.f. amplifier Model 1442 suitable for voltage amplification in the frequency range 5 c/s to 3 kc/s, a wide-band amplifier Model 1439 for television and v.h.f. radio distribution systems, and a



Wooster automatic recording microdensitometer Mark II.

directly coupled pre-amplifier Model 1440 for use in cascade with a further amplifier or with a recording device. A 6V transistorized power unit Model 1326, a laboratory power unit Model 1328 for use as a power source for transistor equipment and a battery eliminator Model 1327, designed primarily to power the Cossor pre-amplifiers, will also be shown.

Oscillograph Model 1039M Mk II, the smallest in the Cossor oscillograph range and weighing only 10¼ lb. will be shown together with cameras which have been developed specially for use with Cossor oscillographs.

The two chief items to be shown by **Crystal Structures Ltd.** (Stand 4) are the Wooster automatic recording microdensitometer Mark II, and the Wooster automatic line-seeker. The first of these is a more compact instrument than the original model, all the electronics being housed beneath the carriage, the rotation of the light shutter providing the necessary cooling. Two lead-screws at right-angles permit automatic traverses to be made in perpendicular directions. The largest films likely to be used by crystallographers—28·5 cm. × 12·5 cm. can be accommodated on the carriage. The second item is designed to find automatically the centre of an X-ray reflection which may extend over a small angle or over a range of several degrees.

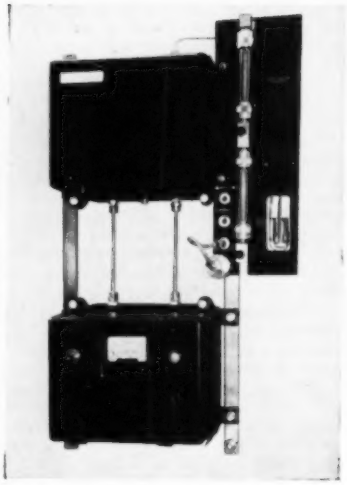
Dawe Instruments Ltd. (Stand 128) will include pulse generators, oscillators, frequency meters, ultrasonic generators, stroboscopes and noise level meters, in their comprehensive range of equipment. The oscillators exhibited will include a fully transistorized battery operated type, which gives continuously variable frequency coverage over the range 20 c/s and 20 kc/s in three decade stops. Other exhibits will include Type 614C valve voltmeter, a transistor photo-electric pick-up designed to trigger a Type 1200 stroboscope in synchronization with a rotating mechanism, Type 1156 250W Soniclean generator, and various types of stroboscopes. The Type 1405 objective noise meter has been designed for use in application where a greater accuracy is required than can be achieved with the Type 1400 sound level meter and also in high sound fields and under conditions of extreme vibration such as are found in aircraft. The acoustic calibrator Type 1411B has been specifically designed to check the calibration of the objective noise meter Type 1405 which uses the S.T.C. Type 4021J microphone.

Six Grade 1 microwave attenuators covering the frequency band 1700-18000 Mc/s. and designed to make accurate attenuation measurements will be exhibited by **Decca Radar Ltd.** (Stand 23).

The recently developed WG 8 Grade 1 test equipment is representative of a wide range of Grade 1 instruments available in five waveguide sizes. With the standing wave meter it is possible to make VSWR measurements to better than 0·5 per cent guide wavelength measurements to better than 0·2 per cent and the carriage position is indicated to ± 0·05 mm. over a range of travel of 34 cm. A complete noise factor test set is included in a portable case. The measurement is made to an accuracy of ± 0·5 db by means of an IF attenuator calibrated directly in noise factor. No calibration curves or RF attenuators are required. Special examples of electroformed components such as junctions, couplers, rotating joints, switches and transformers will be exhibited to demonstrate the latest techniques of electroforming. A wide range of attenuating elements for standard rectangular waveguide will be shown. Resistive discs for coaxial-line systems will also be on show, together with a new and compact form of low-power load for rectangular waveguides.

Eight D.S.I.R. stations and two Research Associations will be exhibiting on the **D.S.I.R.** stand (Stand 47). They are the National Physical Laboratory, the Mechanical Engineering Research Laboratory, the Hydraulics Research Station, the Road Research Laboratory, the Building Research Station, the Low Temperature Research Station, the Joint Fire Research Organization, the Radio Research Station, the British Steel Casting Research Association, and the British Cast Iron Research Association.

Three types of automatically-functioning equipment will be displayed by **The Distillers Co., Ltd.** (Stand 50). *D.C.L. null balance magnetic oxygen analyser.*—This instrument has been developed for the analysis of oxygen in any mixture of common gases such as flue gas, inert atmospheres and gas process streams. It measures the magnetic susceptibility of a continuously flowing sample, using a feed-back system. The instrument will be shown with the new ultra-rapid D.C.L. multipoint gas sampling panel, which enables



D.C.L. oxygen analyser.

gas to be taken from any one of a number of sample lines simply by inserting a bayonet plug into the appropriate socket. *D.C.L. panoramic temperature display unit.*—This instrument displays a cathode ray tube the temperature distribution in a chemical reactor or other thermal system. *D.C.L. metering pumps.*—The D.C.L. range of variable capacity pumps has been developed for the accurate metering of small quantities of fluids, in connection with distillation processes, antibiotic research, catalyst injection, water treatment and similar operations where constant pre-set flows are a requirement.

Two types of trace analysis equipment will be shown by **Dobbie McInnes (Electronics) Ltd.** (Stand 127). In the first (TRA) the measurement is made as a resistance analogue, then sealed electrically and passed to an analogue/digital converter before applying to a punching or tabulating unit. In the second type (TRD) the reading cursor operates a digitizer which, after decoding, directly operates the punch or tabulator. The overall accuracy is of the order of 1 part in 1,000 and readings can be maintained at speeds of one every two seconds. The various units such as decoders and impluse counters with visual displays and serial output for typewriters, etc. are also supplied as separate self-contained units. An analogue/digital converter is a new addition to the firm's range of instruments. This unit is designed to convert d.c. analogue voltage levels to decimal digits with sign with a resolution of 1 part in 999.

A new form of automatic titration apparatus will be shown by **Doran Instrument Co., Ltd.** (Stand 117) in which the indicator as well as the controlling equipment with the requisite relays, etc. are all mounted in a single

Mini thermocouple potentiometer. *Doran Instrument Co., Ltd.*

case with the titration stand fitted on one side. A precision general purpose d.c. potentiometer internal reflecting with galvanometer has three ranges of 1 microvolt to 18 millivolts, 10 microvolts to 180 millivolts and 100 microvolts to 1·8 volts. It has an accuracy of 0·02 per cent of the maximum reading of the range in use. In the latest model provision is made for controlling the supply circuits independently, i.e. the potentiometer can be kept switched on in order to obtain steady conditions, and the lamp which is provided for the reflecting galvanometer need only be switched on when readings are to be taken. A pH test unit will be shown which provides input voltages for checking pH meters and high impedance potentiometers using an electrometer valve. Also on view will be a Mini thermocouple potentiometer, a portable Wheatstone bridge comprising a four dial decade resistance box having a total resistance of 11,110 ohms with ratio arms to give ratios of 0·001, 0·01, 0·1, 1, 10, 100, and 1,000 and a vernier potentiometer which has three dials giving readings from 10 microvolts to 1·89999 volts with an accuracy of the order of one part in 100,000 of the 1 volt setting.

Dynatron Radio Ltd. (Stand 134) will be displaying and demonstrating their latest nucleonic instrumentation. Being exhibited for the first time is a prototype Dynatron nucleonic test set. Another prototype being shown for the first time is the transistorized pulse amplifier and power supply for use with proportional counters designed for use in slow neutron counting. Its specific application is for soil density and moisture content measurements. The essential function of the power unit N.104/5 is to provide a source of stabilized e.h.t. for G.M. tubes and ionization chambers. The highly stablized power unit N.103 will supply the high voltage needed by most types of counters used in nuclear physics, especially scintillation counters and other proportional counters where extreme stability is required.

The latest developments in rotary high vacuum pumps, ultra high vacuum equipment, vacuum measuring instruments, leak detection equipment, vacuum coating plant and metallurgical and distillation plant will be exhibited by **Edwards High Vacuum Ltd.** (Stand 149). An automatic large scale pumping system with liquid gas transfer equipment will also be shown and examples of vacuum coating will include metal film resistors, infra-red reflectors and aluminized cathode ray tubes. An item of particular interest will be the vacuum fusion gas analysis unit for the analysis of oxygen, nitrogen and hydrogen in metal samples.

The exhibits of **Ekco Electronics Ltd.** (Stand 39) will comprise a selection of recently developed nucleonic instruments for use in the fields of medicine, industry, research and reactor instrumentation. These will include scintillation counters, ratemeters, radiation monitors, linear amplifiers, gamma monitors, aircraft transistor inverters and an X-Y plotter.

Electronic Tubes Ltd. (Stand 60) will be giving demonstrations of the progress of cathode ray tube design culminating in a new tube with increased deflection sensitivity, dual trace tubes, battery operated tubes and a tube with a new type of screen phosphor.

Electronic drum stores and tape decks, humidity detectors, atomic radiation monitors, stroboscopes, oscilloscopes, electronic photographic enlargers are only a few of the items to be shown by **E.M.I. Electronics Ltd.** (Stand 122). Of particular interest is the new ultra-high intensity precision stroboscope Type 6. Designed around an entirely new Xenon discharge tube, this instrument provides a unique and invaluable means of studying rotating, vibrating or reciprocating mechanisms in laboratories and workshops without the need for extensive 'blacking-out'.

The Baker integral-sheath thermocouple comprising a flexible metallic outer sheath insulated from the central thermo-elements by means of a pure oxide refractory powder is one of the exhibits to be shown by **Engelhard Industries Ltd., Baker Platinum Division** (Stand 101). It was developed to fulfil the requirement for a noble metal thermocouple assembly having flexibility and thermal shock resistance. Corrosion-free, precious metal-clad thermocouple contacts with a low, stable contact resistance, for use in the measurement of fuel-element can temperatures will also be exhibited. Also on this Stand will be recombination catalysts for use with radiolutic gas and tail gas treatment gases for use to reduce the nitrogen oxide content of the fumes occurring in nitric acid production; another exhibit will demonstrate the Baker 'Atomex' immersion gold solution method of applying a thin, dense, adherent coating of pure gold to a variety of metal without the use of electric current.

Various types of daylight viewing storage tubes will be featured by the **English Electric Valve Co., Ltd.** (Stand 100) together with valves for eddy current heating, an image intensifier orthicon, germanium rectifiers, magnetrons, klystrons, travelling wave tubes and backward wave oscillators. The company also hope to have on show other new valves and tubes which are now in development.

ETL-NPL automatic polarimeter, Type 143A.

One of the most recent developments to be shown by **Ericsson Telephones Ltd.** (Stand 97) will be the industrial batch counter, Type 165A, which has been designed specifically for use with positive displacement flowmeters to facilitate the dispensing of accurate quantities of liquid, and which may also be used for any other process where predetermined quantities of discrete units or articles are required to be batched. Another exhibit will be the ETL-NPL automatic polarimeter, Type 143A, which has been based on an original design by the National Physical Laboratory. Other exhibits will include transistor counting and arithmetic units, unitized counting equipment, vibrating reed electrometer, punched tape preparation unit, digital ohmmeter, digital voltmeter, rotary motion pulse generator (Rotapulse), and bi-directional transistor counter with digital indicator. A comprehensive selection of electromagnetic devices and special tubes for counting, timing and control will also be exhibited.

Evans Electroselenium Ltd. (Stand 62) will exhibit a wide range of EEL photoelectric instruments, including the fluorimeter for the measurement of the fluorescence of liquids, the titrator for complexiometric titrations, the adjustable gloss head for the measurement of gloss throughout the range of 15-85 deg., and the street lighting photometer for the assessment of light values. New multi-range galvanometers will also be exhibited, among which will be included a D.C. millivoltmeter plus an oil-filled unit of exceptional robustness. These taut suspension galvanometers are recent developments available to manufacturers for incorporation in a wide variety of instruments.

On show at the **Ferranti Ltd.** stand (Stand 46) will be the latest types of silicon devices including fast diodes, alloy diodes and diffusion rectifiers with higher permissible reverse voltages, reference diodes for voltages between 3 and 10 volts and rectifiers for currents over 100 a. Working exhibits will demonstrate the operation of two and three terminal switching diodes of the four-layer type, transistors, and solar cell units in which he photovoltaic

The EEL fluorimeter.

Ferranti digital voltmeter.

effect is used to operate a switching device. Also exhibited will be samples showing the latest developments in silicon technology. The display of ceramic-metal sealing techniques will include new production components involving ceramic-metal seals, high temperature seals to 100 per cent alumina ceramics (1250°C. brazing temperature), copper disc seals, pin seals and large diameter compression seals to high alumina ceramics. The klystron exhibits will include a range of X-band klystrons suitable for c.w. radar application and Type VA201B klystron made under licence to Varian Associates. Work has been proceeding with the development of a new photomicrographic flash tube and it is hoped to arrange a demonstration.

The Ferranti transistorized tape reader TR.7 has been designed for equipment such as electronic digital computers which require the input of information at high speed. Digital voltmeters and ohmmeters will be shown, the latter being introduced for the first time.

Two types of monitor will be shown by **Fleming Radio (Developments) Ltd.** (Stand 7). The first of these—the effluent monitor—is a portable self-contained instrument for use in monitoring any effluent, ponds, lakes or rivers contaminated with radioactive material. The second—an automatic air pollution monitor (radioactive version)—consists of a basic air pollution recorder, with a built-in unit for checking radioactivity in the sample.

Furzehill Laboratories Ltd. (Stand 14) are exhibiting a number of new items, among which will be two new oscilloscopes and a new logarithmic valve voltmeter. A demonstration will be given of a three-phase variable frequency supply. This equipment was originally developed for testing of speedometers and similar devices requiring a series of accurately known shaft speeds. A precision R.C. oscillator is employed set to a number of preselected frequencies. This oscillator provides two outputs in quadrature which are then fed through a power amplifier delivering a three-phase supply which is used to drive a synchronous motor/gear box assembly. Final shaft speeds are obtainable over a wide range of a few hundred to several thousand r.p.m. with an accuracy of better than 0·25 per cent. Alternatively the equipment can be supplied simply as a three-phase supply at any required frequency or range of frequencies with power from 50 watts up to several kilowatts, as required.

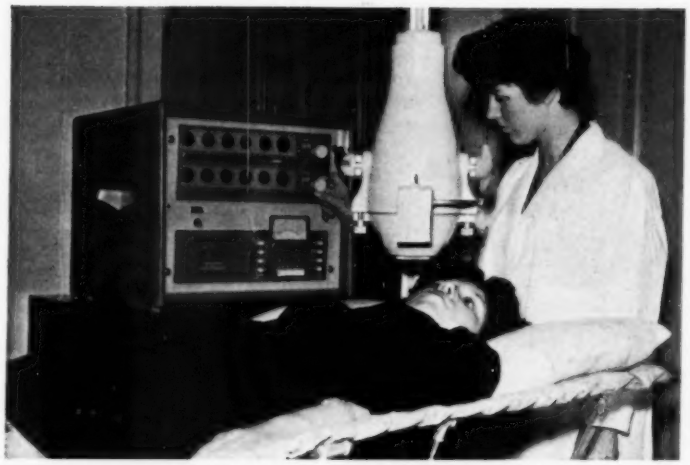
The General Electric Co., Ltd. and the M.O. Valve Co., Ltd. (Stand 27) will be showing a large range of new valves, cathode ray tubes and semi-conductors, as well as an R.F. reflectometer and some applications of G.E.C. heavy alloy.

On Stand 25, the **G.E.C. Research Laboratories** will include an experimental four-way microwave switch which enables low level microwave signals to be switched between a common line and any of four others. There will al so be on show a prototype induction digitizer, and a new range of lightweight high voltage resin cast transformers.

The Griffin & George Group of Companies (Stand 123) will be exhibiting the Griffin-Raleigh elution bridge, designed primarily for monitoring washing processes in transistor production and in the electro-plating industry, and the Griffin panmetron bridge, a mains-operated instrument which serves as an a/c bridge for comparing resistance and reactance at 50 cycles/sec using external standards, and also as a high gain detector amplifier for use with external bridge circuits. Bateman's jet reaction apparatus will demonstrate that force is proportional to the rate of change of momentum and enables a value for the acceleration due to gravity to be determined. The Griffin VPC apparatus Mark 26, and the Griffin-Raleigh water de-ioniser (which was the subject of a Test Report in the December 1958 issue of *Laboratory Practice*) will also be on view.

Two items will be shown by the **Department of Physics, Hammersmith Hospital** (Stand 52). These are:

Quantitative Automatic Body Scanner for Localization of Radioactive Isotopes in vivo.—This machine is an attempt to show the distribution of radioactivity in the body in a manner which is both pictorial and quantitative. The patient lies on a floating-top couch and is moved in a raster beneath a scintillation counter. The output of the scintillation counter is fed into a ratemeter and recording ammeter in the usual way, but the ammeter, which is fixed to the floating top of the couch, carries a printing mechanism which is such that the count



Scaler being used for medical diagnostic work in conjunction with the diagnostic scintillation counter, Type 700. *Isotope Developments Ltd.*

rate selects the colour of spot which is printed. The final result is an even array of spots covering an area of paper equal to the area of patient scanned, and regions of the body which give a count rate within a certain range are shown as areas of dots of the same colour.

Tritium Counter for Routine Use.— This is a coincidence counter using a liquid scintillator contained in a vessel viewed by two photomultipliers, assembled inside a deep freeze chamber. A sample is changed by running out the previous one and pouring in the new one. The counter has an efficiency of 30 per cent with a background of 6 c/s and is used for samples of tritiated steriods. It is also used for counting samples of tritiated water at somewhat lower efficiency.

Among the components to be shown by **The Infra Red Development Co., Ltd.** (Stand 87) will be: variable and pre-set throttling valves capable of giving a fine control of gas flow rate at pressures up to 200 p.s.i.; flow controllers to give a constant pre-set flow rate in the range 0·25-1·25 litres per minute with pressure drops varying between 40-300 mm. Hg; pressure relief valves to operate at pressures as low as 2 in. water gauge; absolute pressure regulators to maintain the gas stream in a cell at a constant predetermined pressure, and end of line and visi-filters and gauged piston tap assemblies.

Isotope Developments Ltd. (Stand 136) will show a wide range of instruments covering many industrial, medical and research applications. Among these will be the scaler, Type 1700, which incorporates a complete and automatic counting apparatus in a single table-top unit; diagnostic scintillation counter, Type 700; Gammalarm, Type 656, a simple, self-contained radiation monitor for wall mounting, used in radiotherapy departments, laboratories, irradiation facilities, and any areas where gamma radiation may occasionally exceed the normal background level; scintillation counter, Type 661; single channel pulse height analyser, Type 672A; portable scintillation counter, Type 1413A, and a beta gauge, Type 150, designed for the continuous measurement of thickness of all types of sheet or strip material.

An extensive range of noble metal resistance wires will form part of the display to be staged by **Johnson, Matthey & Co., Ltd.** (Stand 110). Several new silver metallizing preparations will also be shown, together with two new ranges of precision silvered mica capacitors. Other exhibits will include anodes and salts for the electrodeposition of gold, silver, rhodium, platinum, palladium and indium and the application of platinum metals in temperature measurement.

A highly specialized display of precision instrumentation from the **Kelvin Hughes** group (Stand 120) will be assembled on the company's stand. Designed to appeal to the marine, electronic, electro-mechanical and aeronautical engineer, the exhibits include developments of previously exhibited components, but the major part of the equipment will be on show for the first time. Items will include a direct reading current meter, Syncrotel transmission system, stabilized power pack for klystrons precision slide wire potentiometer, force-balance system for pressure measurement, air data computer, twin channel flaw alarm, ultrasonic transducers and a periscopic sextant with sky compass facility.

The three main exhibits to be shown by **Lintronic Ltd.** (Stand 17) will be a magnetic core type binary shift register unit and scaler unit, a differential pressure gauge with linear response for flow velocity indication, and an unbonded strain gauge pressure transducer —a two active-arm strain gauge each with 800 ohms resistance.

The double-image microscope micrometer with facilities for accurate particle size analysis will be one of the exhibits to be shown by the **Pneumoconiosis Research Unit of the Medical Research Council** (Stand 60A). A vibrating mirror is introduced between the objective and eyepiece of a normal microscope optical system and the illuminant is arranged to flash when the mirror is in its extreme positions, so that two images of the particles are seen in the field (as illustrated in Fig. 1), separated by a distance proportional to the movement of the mirror. The mirror itself is mounted on the diaphragm of a loudspeaker-type transducer and its amplitude of vibration is controlled by the strength of the 50 c.p.s. energizing current. The diameter of a sphere can be read off a calibrated ammeter after the current has been varied until the two images just touch; the setting is critical and will give reproducibility better than 1 per cent at 10μ and 3 per cent at 1μ. The various dimensions of an irregular particle and the distance between two points within the periphery of an object may also be determined. The size of moving objects may be determined, a feature especially useful in biological work.

Size analysis may be carried out in a number of ways. In one such method, setting a switch to the position for a given size range results in the image separation being given a value corresponding to the lower limit of the range during odd half-seconds, as in Fig. 2a, and to the upper limit during even half-seconds, as in Fig. 2b; one can distinguish which of the particles are in this range by the fact that their image pairs alternately show overlap and no overlap, and their number is registered on an electromagnetic counter, selected by the same switch. The limits of the size ranges are easily set to the desired values, and

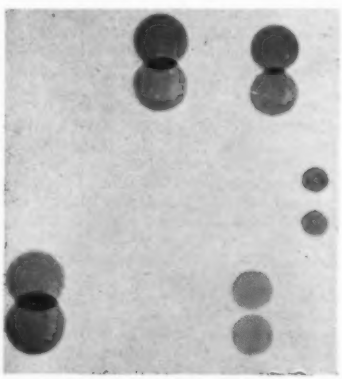


Fig. 1.

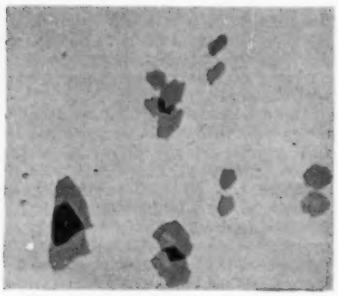


Fig. 2a.

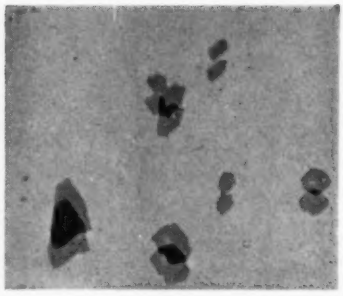


Fig. 2b.

may be as close as 0·1μ. A good counting rate can be maintained for long periods. Especially for occasional use, the zero warming-up time of the instrument is an advantage in keeping total analysis time short. Projection may be employed.

Some applications of the instrument will be demonstrated at the exhibition.

Other exhibits on this stand will be a size separating sampling instrument for airborne particles, a nitrogen meter for the investigation of lung function and a time-multiplex oscilloscope for electro-encephalography.

A range of different shapes and sizes of mounted and unmounted selenium photocells with different spectral characteristics will be shown by **Megatron Ltd.** (Stand 21). The 'potted' two pin units can be plugged into standard sockets and are most suitable for photoelectric relay work, counting, etc. Besides the well-known range of cosine corrected light meters C1-C3 and C5a, an integrating light meter developed in co-operation with National Institute of Agricultural Engineering will be shown, together with samples of three different types of coatings on glass which are being used on antistatic instrument windows and for de-misting and defrosting, electro-luminescence, etc.

Mervyn Instruments (Stand 118) will include in their display the Mervyn-WPRL wide bore polarographic electrode which enables a continuously flowing liquid to be monitored by polarographic techniques, which are not conveniently achieved with the conventional dropping mercury electrode. Other exhibits on this stand will be the Mervyn-Harwell square wave polarograph Mark III, the Mervyn-Cerl sulphur dioxide recorder, the large area alpha scintillation counter, designed specially for samples of low activity and having over twice the scanned area of any other counter, and an experimental low frequency tripping equipment built in conjunction with the Transmission Design Branch of the Central Electricity Generating Board.

Metropolitan-Vickers Electrical Co., Ltd. (Stand 147) feature an X-ray microanalyser, which enables quantitative chemical analyses to be performed with small volumes (about 1 cubic micron) of material employing the technique developed in France by Castaing. This analyser was developed by the Associated Electrical Industries Research Laboratory at Aldermaston, and is the prototype of production models at present being constructed by Metropolitan-Vickers. Three spectrometers will be on show. The first, a Type MS7 double-focusing mass spectrometer of the Mattauch type primarily for the analysis of impurities in solids; the second, a 2 in. radius laboratory mass spectrometer for use in those applications where it is necessary to determine directly the composition of gases and vapours in an apparatus without any intermediate sampling; and the third, a Newton-Victor 'Raymax 60' x-ray fluorescence spectrometer.

Other exhibits will include a model of a vacuum system for Zeta, an ultra high vacuum plant, high vacuum equipment, a peak-reading digital voltmeter, a periodic table of the isotopic abundance of the naturally occuring elements (this exhibit was devised for use in the International Hall of Science at the Brussels Exhibition) and charts and diagrams illustrating investigations into the degassing rates of various materials.

Muirhead & Co., Ltd. (Stand 107) will demonstrate the transfer function analyser in connection with a model servo system. The D-880-A 2 phase low frequency decade oscillator, also to be shown, has a frequency of 0·01 c/s to 11.2Kc/s. Two outputs—90° apart—are available at a maximum level of 10 V. Another exhibit, the D-888-A high frequency analyser/oscillator, can be used either as a sensitive, constant gain frequency analyser (with a Q-factor of not less than 70, an octave discrimination of 40 dB and a minimum indication of 50 microvolts) or as an oscillator (with an output level of 2·5 V into 500 ohms, Miniature size 08 synchros will be exhibited with size 08 and size 10 servomotors and size 11 linvars, and another recent development on show will be a size 11 gearhead specially designed for mounting in instrument servo-mechanisms and size 11 servomotors to Bureau of Ordnance, Society of Automotive Engineers and/or Royal Aircraft Establishment specifications.

Many examples of items fabricated in tantalum, niobium, tungsten, molybdenum and zirconium will be shown by **Murex Ltd.** (Stand 85). These five metals are available in the form of rod, sheet and wire and can be fabricated by spinning, welding and machining to form many units which are of interest to the chemical and metallurgical industries. Condensers for hydrochloric acid plant, bayonet heaters and other items of corrosion resistant chemical plant fabricated in pure tantalum are displayed. Internal units for high temperature furnaces are fabricated in tungsten and molybdenum and many items in these metals are made for the electronics industry. The company will also be showing a range of sintered permanent magnets together with Sincomax composite magnets which find particular application in the instrument industry. Examples of the recently developed magnetic alloy Comalloy will be available. This alloy has the property of being sufficiently ductile to be machinable prior to final heat treatment. Sintered iron pole pieces will also be shown and are available for industry.

The **National Institute of Agricultural Engineering** (Stand 55) hope to have on show a photo-electric seed counter, designed primarily to count or batch small quantities of cereal grain for subsequent research studies; two resistance strain-gauge torquemeters, developed for use in tractor testing; a mechanical unit for analysing recorder traces, and two systems for varying the thermostat setting in a glasshouse according to the intensity of solar radiation being received.

Two basic types of galvanometer recorders will be shown by **New Electronic Products Ltd.** (Stand 9). One of these uses the standard tungsten light source and photographic paper necessitating photographic processing before the trace is available. The other recorder has an ultra-violet light source and special printout recording paper—in this instrument the trace is visible after a few seconds' exposure to ambient light. As a result of its extremely high writing speed, this system allows transients to be observed that would have been missed on the photographic recorder or oscilloscope. A six-channel carrier amplifier recently developed will also be exhibited, together with a magnetic tape recorder, a double-pole, double-throw miniature relay, and a range of differential inductance pressure transducers developed for continuous use at temperatures of 200°C.

The exhibit of **Newport Instruments (Scientific & Mobile) Ltd.** (Stand 41) is mainly planned as a working demonstration of simple and economical nuclear magnetic resonance equipment. A Newport 4 in. electromagnet Type A —high homogeneity model will be mounted on a rotating base Type A

which in turn is mounted on a Newport current stabilized power supply unit Type B. A direct-reading magnetometer Type G will also be exhibited covering the range to 1,000 gauss with a sensitivity of 10 milligauss per scale division, to examine the magnet's stray field. The exhibit will also include illustrations of other standard electromagnets in the Newport range.

The 'Niometer' bonding and insulation tester, completely self-contained and hermetically sealed in a plastic-coated aluminium case with leather shoulder strap, contains a rugged centre-pole moving coil meter, a resin-encapsulated transistorized drive circuit, and mercury cells which will give many months of normal use.

Nuclear Enterprises (G.B.) Ltd. (Stand 81) will be displaying a range of scintillation materials and precision nucleonic instruments. Included in the scintillation materials will be the plastic phosphor scintillator NE102 which may be used with burst slug detectors, special well counters, human body counters, high energy proton telescopes or thin sheets for alpha and beta counting. Liquid scintillators, NE211 and NE212 will also be on display. Also included in the exhibit will be loaded liquid scintillators, scintillating gels and sodium iodide (thallium activated) crystals. Among the precision nucleonic instruments to be shown will be a complete assembly for C14 and tritium counting—the NE8301. This assembly consists of a non-blocking linear pulse amplifier NE5202, a single channel differential pulse height selector NE5102, a stabilized E.H.T. supply NE5302, and a shielded scintillation head unit NE5502.

Extensive tests with the first prototype quartz fibre ultra micro balance have led to a number of modifications and improvements incorporated in the production prototype to be shown by **L. Oertling Ltd.** (Stand 111). The instrument is designed to weigh with an accuracy of 0·1 microgramme, and to be capable of handling loads of up to about 0·5 g. A new design of high speed precision semi-automatic balance giving dead-beat readings with a capacity of 2 kg. in each pan and a sensitivity of 0·1 g. per scale division, will also be shown together with the range of one pan balances, first introduced in 1957, incorporating full mechanical manipulation of all weights on all models. The range of two pan balances now comprises 14 different models with sensitivities ranging from 0·1 mg. to 2 mg. per scale division, and with different ranges of automatic weight manipulation.

Oertling's quartz fibre ultra micro balance.

Among the new instruments to be demonstrated by **W. Ottway & Co., Ltd.** (Stand 94) will be the 'Orion' 6 in. F8 Newtonian astronomical telescope. The parabolic mirror is polished and figured with an accuracy to $\frac{1}{8}$ wavelength of visible light. The telescope body is of low thermal conductivity inpregnated plastic tube. A prototype slotted template cutter developed for the Ministry of Supply will also be demonstrated together with a laboratory reading and aligning telescope, survey levels, smoke density sighting equipment, oscillograph camera lenses and scaleometers.

Eight exhibits will be featured by **Panax Equipment Ltd.** (Stand 11). These will be as follows: scintillation castles, Type SC/LP; scintillation counter unit, Type USC/A; directional scintillation counter, Type DSC/1; Universal lead castle, Type LC/3; variable gain pulse amplifier, Type 4250; portable radiation monitors, Type TR56B and TR56H; automatic counting equipment, Type AC300/6; and scaling attachment, Type SA/100.

A range of replica diffraction gratings produced by the Merton/N.P.L. process primarily intended for use in the ultra-red region will be shown by **Paton Hawksley** (Stand 112). Gratings will also be shown which are intended for educational purposes and students' use.

Other exhibits include a full range of graticules, diffraction gratings for metrology, strain indicator, divided circles and scalloped gratings.

The Physical Society (Stand 24) will have on their stand a selection of their publications, including Proceedings of the Physical Society, Reports on Progress in Physics, Year Book of the Physical Society, Handbook of Scientific Instruments and Apparatus, and various Conference Reports.

A new type of printed electronic circuit in which copper patterns are firmly bonded to a glass base will be shown by **G. V. Planer Ltd.** (Stand 133). New types of indium antimonide magneto-sensitive resistors and Hall effect elements will be shown, and also an electrolytic co-precipitation method of preparing mixed oxide powders suitable for the production of magentic ferrites. Other exhibits will include an ignition unit incorporating a liquid filled polyester film capacitor for operation over a wide temperature range, and new types of temperature stable barrier layer ceramics with effective K values of 300,000 and low dielectric losses. 0·5 uF capacitors encapsulated in epoxide resin will be shown.

Gauge for measuring thickness of wafers of germanium or silicon. *Courtesy H.M. Postmaster-General.*

A magnetic frequency divider, an electronic speech voltage measuring device, a telegraph distortion analyser, a bridge for measuring losses in magnetic materials at high flux densities, an improved machine for lapping germanium and silicon slices, and a gauge for measuring thickness of wafers of germanium or silicon, are to be exhibited by the **Post Office Engineering Research Station** (Stand 30). This latter instrument employs the optical lever principle and gives an overall accuracy, including the effects of temperature changes in normal use, of 0·5 micron over a thickness range of 0-270 microns. The hemispherical probe point, of 40 microns radius, exerts a force of 3 g. on the specimen, which rests on a glass optical flat. Provision is made for feeding the gauge with a supply of dust-free air.

R. B. Pullin & Co., Ltd. (Stand 133) will be showing for the first time the 7-terminal size 11 control resolver R982-21B Bu-Ord 11R13N4 and a 6V miniature governed speed motor with adjustable governed speed which is intended for 1,000 hours continous operation without attention and is designed to take minimum possible current from the battery. On this stand there will also be samples from the Pullin-Kearfott range of size 11 and size 18 synchros and size 10 servomotors for germanium and silicon transistor-amplifier operation; size 10 motor generator with 400 c/s motor and an integral damping generator; type TAIG miniaturized resin encapsulated germanium transistor amplifier; a range of standard and governed speed permanent magnet d.c. motors; type 18 PMT tachometer generator which is suitable as a linear voltage signal

source for integrating and computing circuits; and an in-line, rear-projection type digital display unit.

The argon chromatograph using an argon detector will be exhibited by **W. G. Pye & Co., Ltd.** (Stand 104). Examples of pH equipment will include a portable meter, a Dynacap meter, a Dynacap industrial meter, and a flow type pH electrode assembly. The remainder of the exhibit will consist of a decade potentiometer stabilized power supply unit, galvanometer, l.f. oscillator instrument switch, portable Wheatstone bridge, decade resistance boxes, electro static voltmeter, thermocouple test set, high resistance test set, and single channel recording thermometer.

In the display arranged by the **Royal Swedish Academy of Engineering Sciences, Stockholm** (Stand 151) the following institutions are represented: Swedish Research Institute of National Defence, Nobel Institute of Physics, Stockholm, University of Lund, University of Uppsala, and the Research Laboratory of LKB-Produkter Fabriksaktiebolag, Stockholm. Among the exhibits will be:

A ring slit sifter for the quick analysis of the particle size distribution in granular materials.

A small diaphragm pressure gauge with photo-cell.

A small light apparatus for measurements of very short intervals of time.

A blood pressure gauge with amplifier for instantaneous electrical recording of changes of the blood pressure in live organisms.

Apparatus for recording temperature, humidity, and refractivity of the air.

A non-reciprocal microwave attenuator.

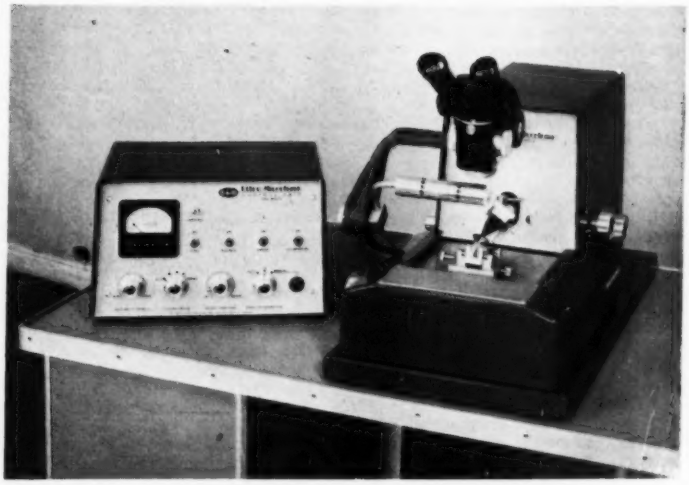
A compensating calorimetric power meter.

The Nobel Institute of Physics will be exhibiting a microscope object stage for convenient measuring of tracks of charged particles in photographic emulsions or other objects in transparent media.

The University of Lund will show a 'Miniflow' precision micro pump for use in chromatographic work, and the University of Uppsala a column electrophoresis apparatus.

LKB-Produkter Fabriksaktiebolag will have on show an ultra-microtome, a recording ultra-violet photometer for streaming solutions, a continuous conductivity analyser, and preparative paper chromatography columns.

The Midas system of magnetic tape data recording and processing using a frequency modulated carrier and $\frac{1}{4}$ in. tape, giving simultaneous recording of seven signal channels and one reference channel, will be shown by **Royston Instruments Ltd.** (Stand 33). The range of recorders covers transportable, rack mounting, continouus loop and miniature flight recorders. The calibrator and playback unit and analyser will also be exhibited.



LKB-Produkter ultra-microtome.

Salford Electrical Instruments Ltd. (Stand 26) will be showing a representative range of crystal units, packaged oscillators, toroidal cores and ferrites. Development samples of high frequency shear mode crystals will be on view. These operate at third or fifth overtone at frequencies up to 5 Mc/s. Also in the development stage is a range of miniaturized flexure mode crystal units. Enclosed in hermetically sealed metal holders, they cover the range 2-30 kc/s. In the frequency range 500-1000 Kc/s. are the low frequency AT cut crystals, while a new transistorized quartz crystal packaged oscillator employs a printed circuit technique.

A range of miniature X-band ferrite isolators will be shown by **W. H. Sanders (Electronics) Ltd.** (Stand 18). Other exhibits on this stand will include bench oscillators, a microwave educational test bench, the bench and supports of which have been so constructed that any instrument may be detached from it and substituted by some suitable ancillary equipment which is housed in a special drawer below the base of the bench, and a flexible waveguide.

The three main items to be shown by **Sangamo Weston Ltd.** (Stand 140) will be Model S 228 averaging resistance thermometer bulb, designed to measure temperatures of bulk-stored liquids, Model S 229 average temperature indicator for use with the averaging resistance bulb and comprising a 6 in. scale indicator complete with element selector switch and housed in a weatherproof cabinet, and the S 144 Form 5 servo-potentiometer using phototransistors.

The **Science Museum's** exhibit (Stand 56) will consist of a model on a scale of 1:24 of Zeta, the Harwell controlled nuclear fusion apparatus.

D. Shackman & Sons (Stand 86) will be exhibiting a 70 mm. film camera for the first time. It has been developed to provide a larger format area (2 × 2 in.) than that obtained with the normal 35 mm. film cameras. The camera will be used for instrument, document and oscilloscope recording. In addition to the larger picture area, the film capacity has been increased to 200 ft. The camera may be operated automatically for shot by shot recording requiring only a single electrical impulse of 24 volts to operate the focal plane shutter and transport the film ready for the next exposure. For continuously moving film photography the film speed is infinitely variable between 40 in./sec. and 1 in./sec.

The manufacture of some micro-tools used with Singer micromanipulators will be demonstrated by the **Singer Instrument Co., Ltd.** (Stand 143). Instruments to be demonstrated will be:

Singer High Power Micromanipulators.—Suitable for use with any microscope having a magnification range from 100 to more than 1000 diameters.

Singer Low Power Microdissectors.—Suitable for magnification range from 1 to 200 diameters.

Singer Rational Microscope Lamps.—Designed for Kohler illumination.

Singer Burners.—These are improved coal gas Bunsen burners with shrouded jet and air control slide designed to avoid fouling.

A wide range of instruments will be shown by the **Solartron Electronic Group Ltd.** (Stand 103). These come under the main headings of 'Solarscopes', power supplies, the field of servo testing, process control and automation, and computers. Various other items will be shown, such as X-ray fluorescent spectrometers, precision force measuring

equipment, amplifiers, and data handling equipment.

Generators for crystallography, a work table unit, an X-ray diffractometer, an electronic fast counting ratemeter/amplifier, Dekatron gated counter scaling unit and general accessories for crystal analysis research will be featured by **Solus-Schall Ltd.** (Stand 45). Another exhibit will consist of chart recorders which have fast response milliammeter movements, using a continuous line ink pen on synchronous motor operated charts, for tracing diffraction intensities obtained by counter techniques in conjunction with ratemeter/amplifiers.

A range of their Allbritt planimeters, a harmonic analyser, integrator and integraph will be shown by **W. F. Stanley & Co., Ltd.** (Stand 137). They are also hoping to have ready for the Exhibition a harmonic synthesizer, designed by Dr. V. Timbrell. This calculator consists of a baseboard and a series of superimposed transparent sheets, and provides a simple and rapid method for the synthesis of curves comprising up to 24 harmonics.

Dr. F. S. Stott of the Electromedical Research Unit, Churchill Hospital, Headington, Oxford (Stand 59) will be showing a resistance thermometer developed for measuring and recording body temperature in man or animals during surgical hypothermia, a simple pneumatically operated recorder which can be run off a gas cylinder or a compressor, and a high speed red cell counter which is still in an early stage of development.

The Tempunit, an instrument which has been developed specially for the laboratory, where constant temperature water baths are a necessity, will form part of the exhibit to be staged by **Techne (Cambridge) Ltd.** (Stand 32). Other exhibits will consist of the C.M. 2-circle goniometer, a viscometer which operates with clear or opaque liquids of both high and low viscosity, giving a reading directly in poises and eliminating the need for charts and formulae, and a gelation timer.

The Tempunit developed by Techne (Cambridge) Ltd.

During the past year **The Thermal Syndicate Ltd.** (Stand 88) have developed their 'Spectrosil' material so that it can now be used to make a complete range of apparatus, in addition to its optical form in which large prisms, etc. can be provided. 'Spectrosil' is an extremely pure material (total impurities less than 1 p.p.m.) which is completely homogeneous. These properties make it ideal for processing involving high temperatures where the absence of trace impurities is vital and in its optical form it may be used to transmit ultra-violet radiation down to wave lengths of 1650 A. whereas normal grades of fused quartz cannot be used much below 2000 A.

In their general grades of fused quartz the company have aimed at providing large transparent panels for viewing windows where high temperatures are involved and have also developed a method for producing lengths of tubing to tighter tolerances with circular, hexagonal, rectangular and other cross sections.

Further improvements to other more standard products, including transparent tubing, have been made and samples will be shown by the company.

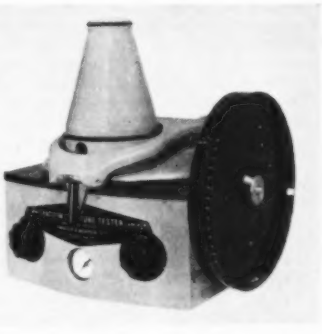
The **J. Langham Thompson** Exhibit (Stand 29) will indicate the considerable progress made by the company, particularly on the development of new transducers. In the recording camera section will be seen the improved version of the Series 200 oscilloscope camera. Using standard 35 mm. film, this camera is now fitted with a switched pole motor, which greatly extends the film speed range. The new BP Series of pressure transducers has an overall accuracy of better than 1 per cent at full output. Another interesting development is a pair of unbonded strain gauge dynamometers designed for the measurement of steady and rapidly fluctuating tensile and compressive forces. A series of unbonded strain gauge load cells will also be shown this year for the first time. A range of digital indicating equipment is also on show for the first time. Broadly speaking this range divides itself into three groups: frequency meters, chronometers, and counters, all of which have provision for operating one or two additional remote indicating units.

Among the comprehensive display of instruments to be staged by **H. Tinsley & Co., Ltd.** (Stand 119) will be a cable fault locator, a flash fault locator, a selection of resistance standards, standard cell batteries and comparators, a thermal conductivity probe, transient needle probe, an Epstein square, a contact modulated amplifier, a furnace flame indicator, and various types of amplifiers.

Complete kits of simple apparatus for colorimetric tests in the printing industry to include tests for the pH of the surface of papers and of aqueous paper extracts, the pH of nickel in plating baths, the copper content of electrotyping baths, and silver in used hypo baths will be shown by **The Tintometer Ltd.** (Stand 90). A much simplified colour comparator for ascertaining that a swimming pool is correctly adjusted for pH and free chlorine content between agreed safe limits will be exhibited. The chemical reagents are for the first time supplied as tablets ready for use. There will also be on show a new model of the B.D.H. Lovibond Nessleriser and artificial light attachment for colorimetric chemical analysis. One of the interesting new developments which may be seen on the stand is the application of the Lovibond portable tintometer to the measuring of the colour of illuminated cinematograph screens.

Two types of countercurrent apparatus will be exhibited by **J. W. Towers & Co., Ltd.** (Stand 126): a microscale automatic type for the separation by multiple extraction of milligram quantities of alkaloids, amines, amino acids, antibiotics, peptides, steroids, vitamins, etc. and a hand operated one for demonstration of use by students. An automatic fraction collector for use in chromatographic analysis, which was designed at the National Institute of Medical Research, will also be shown. Other exhibits will include a Craig type rotary evaporator, a fixed condenser rotary film evaporator, and a range of automatic and analytical balances, electric ovens and incubators.

A new version of the standard size of vacuum oven will be one of the exhibits to be shown by **Townson & Mercer Ltd.** (Stand 108). Also on show will be the production version of the new type of precision thermostat bath developed last year. It incorporates a new type of straight line stirring, and is specifically intended to comply with present and future A.S.T.M. and I.P.T. viscometry test specifications, up to 120°C. A vacuum moisture tester, which takes a 5 g. sample and indicates the actual moisture content direct on a dial, a



Townson & Mercer vacuum moisture tester.

Duplex thermostatic incubator, and a high temperature oil bath complete the display on this stand.

The **Ultrasonoscope Co. (London) Ltd.** (Stand 145) will demonstrate several new developments in the ultrasonic non-destructive field. Among the many interesting types of probes on view will be a 3 mm. crystal diameter probe for the inspection of spot welding; probes employing lead zirconate crystals giving increased sensitivity and shorter pulse lengths and a special turbine testing probe developed on behalf of the Central Electricity Generating Board for the inspection of turbine blades *in situ*. Another exhibit will be the new general purpose portable flaw detector. On the same stand **Glass Developments Ltd.** will present an ammonia Maser oscillator similar in design to that developed by the Signals Research and Development Establishment, Christchurch.

The SP.700 recording spectrophotometer to be shown by **Unicam Instruments Ltd.** (Stand 102) has been under development for some years, and is now in full production. The Unicam spectrofluorimeter, being shown in prototye form, is of particular interest in that it is the first of a series of instruments planned on a 'unit construction' principle, using where possible common, interchangeable components. This, it is believed, will go far towards answering the problem of offering at an economic price a range of highly specialized equipment, the market for each individual item of which may be relatively small.

The **United Kingdom Atomic Energy Authority** (Stand 51) will be showing two types of automatic burette monitor with electronic register: Type A automatically registers on a paper tape the liquid height in a burette. Type B automatically follows variations of liquid height and records them in the form of a graph. The travelling wave oscilloscope to be shown on this stand has been designed for high speed transient recording, requiring only small signal input voltages. Other exhibits will include high speed cameras; differential cathode ray polarograph; and personnel radiation monitoring using photographic emulsions. This exhibit, which is in four sections, will cover some recent developments in film holders and specialized films and also the operation of a monitoring service with examples of data derived from the records.

The range of Vinten 16 mm. cine cameras remains virtually unchanged, and examples of these will be shown by **W. Vinten Ltd.** (Stand 80). These will include the 16 mm. scientific camera Mark I, the 16 mm. scientific camera Mark II, and the 16 mm. high speed camera, designed for recording high speed phenomena. For accurate assessment of speeds, a neon timing lamp is fitted in addition to an event marker in the film gate. Camera control is normally

A Watson stereoscopic microscope on rackwork long arm stand.

remote and the unit is designed to withstand extreme temperatures, high 'G' loadings and vibration.

W. Watson & Sons Ltd. (Stand 95) will be showing a full range of stereoscopic microscopes designed specifically for the needs of industry. The instrument consists of a basic head which can be supplied with vertical or inclined eye pieces, and with a nose piece to take one, two, or three objectives. The range of interchangeable mounts allows this head to be placed in such a position and to have a range of movements appropriate to any particular application. In addition, the new 'Bactil' microscope will be shown. This is a research instrument of the highest standard, with all controls below the stage. It is available as a monocular instrument with either vertical or inclined eye piece, as a binocular instrument with inclined eye pieces, or binocular instrument with the head reversed so that the limb is away from the observer.

The Measurements Laboratory of **The Wayne Kerr Laboratories Ltd.** (Stand 12) will be showing examples of the transformer ratio-arm bridge technique applied to electro-chemistry, mechanical engineering and industrial process control. Measurement of the conductivity and permittivity of liquids will be featured. The Special Products Division, which is concerned primarily with the development and application of resin-cast circuits, will be exhibiting a range of high-voltage apparatus in which the superior dielectric properties of casting resins have made possible the miniaturization of this apparatus.

Various production and prototype instruments will also be exhibited.

The following firms sent details of their exhibits too late for inclusion in the foregoing:

Elliott Brothers (London) Ltd.
Hatfield Instruments Ltd.
The Joyce & Optica Group.
Labgear Ltd.
Ministry of Supply.
Mullard Ltd.
The Plessey Co., Ltd.
Racal Engineering Ltd.
Servomex Controls Ltd.
Siemens Edison Swan Ltd.

VISIT THE U.T.P. STAND

Enquiries concerning their publications will be welcomed by United Trade Press, Ltd., at Stand No. 73. Among the journals and publications to be displayed will be: *Laboratory Practice*, *Instrument Practice Automation and Electronics*, *Automation and Automatic Equipment News*, **'Course in Industrial Instrument Technology', 'Laboratory Control of Dairy Plant', and 'The Industrial Application of pH Measurement and Control'.**

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

Electrical Measuring Instruments.—List No. 118 covering the wide range of electrical measuring instruments made by the company has recently been published by the Doran Instrument Co., Ltd., Stroud, Glos.

Lab Mail.—The September 1958 edition of the Lab Mail issued by Glencreston Ltd. of 41 Church Road, Stanmore, Middlesex, contains details of mills, screw-holders, welding guns and pumps.

Heat-Treatment Journal.—The September issue of the Wild-Barfield Heat Treatment Journal (Vol. VI, No. 48) published by the Wild-Barfield Electric Furnaces Ltd., of Otterspool Way, Watford By-Pass, Herts., and associated companies, contains articles on resistance heated vacuum furnaces, mesh belt conveyor furnaces and forced air circulation.

Biological Stains and Reagents.—George T. Gurr Ltd. of 136-138 New King's Road, London, S.W.6, have issued Price List F in respect of their biological stains and reagents (including scientific dyestuffs).

Marconi Instrumentation.—The September 1958 issue of Marconi Instrumentation (Vol. 6, No. 7) published by Marconi Instruments Ltd., St. Albans, Herts., includes articles on microphony in F.M. signal generators and some practical aspects of pH measurement.

News from the British Association of Chemists

REPORT OF COUNCIL 1957/58

Membership.—The number of new members elected during the year was over 40 per cent greater than the number for the previous year.

Personal recommendation by a member continues to prove the most effective method of recruitment. A Booklet, giving details of the B.A.C. and of such a size that several can be carried easily in the pocket, has been prepared for the assistance of members in this direction. It is hoped that all will make use of it.

Salary Scales.—The Salary Scales Committee issued a revised edition of the Scales, dated January 1958. It has also prepared another revised edition to be dated January 1, 1959. The B.A.C. Scales continue to interest employers and requests for copies are continually being received. From time to time, advertisements of chemical vacancies in the press mention that the remuneration will not be less than that of the B.A.C. Scales.

Financial Advantages to Members.—A Trading Scheme whereby members can make a considerable saving on the purchase of furnishings, etc., with an organization with which the B.A.C. had a similar scheme before the War, has been put into operation and many members have taken advantage of it.

Members continue to show interest in the B.A.C. Group Scheme for private medical and hospital treatment and an increasing number are availing themselves of the favourable rates.

This is also the case in connection with the savings which B.A.C. members can make with regard to Insurance and Assurance.

Legal Aid.—Thirty-three members obtained legal advice, free of charge, during the year. This was in connection with service agreements, the termination of appointment without proper notice, claims in connection with industrial injuries, etc. In one case of industrial injury, the member obtained, through B.A.C. legal aid, a sum of £3,000 in compensation although the original offer was only £600. The corresponding number of members receiving free legal advice last year was 27.

Unemployment Benefit Fund (*Figures quoted are to the nearest* £).—This Fund continues to improve its position. There was a surplus of £1,720 on the year's working and the fund now amounts to £63,431. Unemployment Benefit amounting to £621 and refunds under Rule 22 of £255 were paid during the year. (The corresponding figures last year were £793 and £583 respectively.)

British Celanese Limited.—It is gratifying to be able to record that all except one of the B.A.C. members, whose appointments were terminated as a result of this organization's merger with Courtaulds Ltd., have obtained new posts even though a number of them were over the age of 50. There were, however, some cases of prolonged unemployment and the Association's Unemployment Benefit Fund and Appointments Service were of great value to those concerned.

Advantages of Membership of the B.A.C.

Minimum Salary Scales.
Free Legal Advice on Professional Matters.
Appointments Service.
Unemployment Benefit.
Negotiations with Employers.
Group Scheme for Private Medical Treatment.
Certain advantages in connection with Insurance.
Trading Scheme.
Benevolent Fund.
Lectures, Discussions and Social Functions.

OFFICERS FOR 1958/59

At the Annual General Meeting of the Association, held at the Great Northern Hotel, London, N.1, on December 6, 1958, the following Officers were elected for 1958/59:

President: J. Wilson, C.B.E., M.C., M.Sc., F.R.I.C., F.I.R.I.

Vice-Presidents: A. J. Baker, G. T. Gurr, F.R.I.C., R. J. Mollard, L. E. Puddefoot, B.Sc.,

Hon Treasurer: A. T. Healey, Ph.D., D.I.C., F.R.I.C., A.M.I.Chem.E.

Hon. Secretary: F. W. Kay, M.Sc., Ph.D.

Hon. Registrar: H. L. Howard, B.Sc., A.R.C.S., D.I.C., F.R.I.C., M.I.Chem.,

Trustees: C. S. Garland, B.Sc., A.R.C.S., F.R.I.C., M.I.Chem.E., H. T. F. Rhodes, M.I.E.I., Miss W. Wright, B.Sc., A.R.I.C.

Hon. Editor: H. Warson, B.Sc., F.R.I.C.

General Councillors: There were six nominations for the four vacancies and a ballot was held, as a result of which the following candidates were elected: G. A. Dunn, A.R.I.C., J. F. Neilson, B.Sc., S. Taylor, R. J. Wilkins, B.Sc., F.R.I.C., A.M.B.I.M.

Section Councillors:

Birmingham: J. E. Gregory, B.Sc., Ph.D., F.R.I.C.

Liverpool: T. Q. Matthews, C. J. H. Wylie.

London (Area 1): G. Robertson, H. Morris.

London (Area 2): E. H. G. Sargent, A.C.G.F.C., W. A. Phillips.

Manchester: H. Batley, B.Sc., A.I.M., J. Rickman.

Notts and Derby: A. L. Kennedy, B.Sc., E. Stonehouse.

Yorkshire: G. C. Woodward.

News from the Sections

London

On the evening of Friday, December 5, 1958, a Buffet-Dance, organized by the London Section, was held in connection with the Annual General Meeting on the next day.

Liverpool

The Section's annual Exhibition and Demonstration of Chemical Laboratory Apparatus was held this year at the Liverpool College of Technology on Thursday, December 4, 1958. This function as usual was very well attended and the following firms exhibited and demonstrated apparatus, etc.: Baird & Tatlock (London) Limited, Donald Brown (Brownall) Limited, H. J. Elliott Limited, Griffin & George Limited, John Harcourt, Laboratory Apparatus & Glass Blowing Co., A. M. Lock & Company Limited, L. Oertling Limited, A. E. Parry & Company, The Tintometer Limited, Quickfit & Quartz Limited, and J. W. Towers & Company Limited.

In conjunction with the Exhibition two Scientific film shows, to which students of local schools and technical colleges were invited, were presented. Both of these attracted 'capacity' audiences.

A visit to the control room of British Railways, Lime Street Station, Liverpool has been arranged for Wednesday, January 28, 1959, at 7 p.m.

Birmingham and West Midlands

A lecture entitled 'Analysis and Constitution of Silicones and related Organosilicon Compounds', will be given by J. C. B. Smith, Esq., at the College of Technology, Gosta Green, at 6.30 p.m. on Wednesday, February 4, 1959.

Life Members

The undermentioned have been elected Life Members of this Association:

Robinson, W. G. Elected Member 31.10.25. Liverpool; Tilsley, H. Elected Member 28.11.42. Yorkshire.

Obituary

It is with regret that we record the decease of the following members:

Joseph, W. M. Aged 39. Elected M.10.5.41. Birmingham & W.M.

Milnes, E. Aged 45. Elected M.14.1.54. Yorkshire.

Tayar, R. A. V. Aged 61. Elected M.1.8.23. Birmingham & W.M.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

Laboratory Note-Book

ONE of the world's largest and fastest electronic computing machines—popularly called 'Electronic Brains'—has begun to operate at the National Physical Laboratory. Its name is ACE—and it can carry out any calculation process for which exact rules are known.

Very fast computers of this type are required for many problems of which design calculations for high-speed aircraft and nuclear reactors are typical examples. The emphasis in the N.P.L's use of ACE will however be into the general methods by which computations such as these can be carried out.

ACE is the end-product of research which began at the National Physical Laboratory at the end of the war. In 1945 the late Dr. A. M. Turing, F.R.S., joined the staff of the Mathematics Division at N.P.L. and in the early post-war years he produced, with his collaborators, a logical design for a computer intended to carry some of the load of numerical calculation. He called it the Automatic Computing Engine—or ACE.

In 1947 a special section—now the Control Mechanisms and Electronics Division—was set-up to carry out the development of the machine. It was, however, thought unwise to attempt to build so large and complex a machine in one step—so it was decided to make first a pilot model of considerably smaller power and capacity.

Thus, a pilot-model ACE, only one-sixth of the size of the present machine, was built to investigate the engineering problems which would arise in the full-scale machine. It was completed in 1951 and during its five-year life at N.P.L.—it was presented to the Science Museum in 1956—it carried out a considerable amount of work, including extensive calculations to discover the cause of failure in the early Comet. It was, in fact, the pilot-model which led to the commercial production of the English Electric DEUCE computer. Moreover, it provided the team of mathematicians, logical designers, electronic engineers and mechanical engineers with the essential experience and 'know-how' to undertake the more ambitious full-scale ACE project.

The numbers and instructions have 48 binary digits (equivalent to 14 decimal digits). The working store consists of 800 words, and the backing store of four magnetic drums will contain a total of 32,768 words.

Mercury delay lines and magnetic drums (the working and backing stores respectively) are used for the storage of numerical data and instruction sequences and both punched card and magnetic tape equipment are provided for input and output.

The compact control desk has some 160 keys and 300 signal lamps, in addition to audible and visual displays of the computation. Nevertheless, most computations are carried out entirely by pushing one key—marked 'Initial Input'. This key causes punched cards to be read, which tell ACE what to do.

The most interesting mechanical assemblies in ACE are the four magnetic drums, entirely designed and constructed at N.P.L. The drums rotate at 12,000 r.p.m. so accurately that the arrival at a given point of a magnetic spot one hundredth of an inch in length, travelling at 200 miles per hour, is timed to a millionth of a second. The drums have unique rapidly moving recording heads and are only a part of the number store or 'memory' of ACE. An idea of the speed of ACE can be gained from the fact that these drums are the slowest part of its number store!

ACE incorporates many unique design features. The operating 'mechanism' consists of about 6,000 miniature electronic valves, arranged in an impressive array of 10 large cabinets. Each cabinet is fitted with an electrically operated rising door to give rapid access for fault finding. It has a cooling system of circulating air, with heat exchanges and a water cooler.

Forms of Storage

ACE has three forms of storage. The largest part of the store consists of four magnetic drums. These rotate at 12,000 r.p.m., and store a total of 32,768 numbers. The access to these numbers is limited by the need to wait for the drum to revolve, and may take up to 7 milliseconds (seven thousandths of a second). These drums are used by the computer for the large mass of data that it may not want quickly.

For more rapid access, a mercury delay line store of 768 numbers is employed. The time required for access to these is up to one thousandth of a second. This store is used for the programme, but instructions are stored in such a way that no time is wasted in waiting for them.

The most rapid access store consists of short delay lines storing one, two or four numbers each. These are used for the small group of numbers that the computer is using for a short while.

By good programming, the full advantages of the large store can be enjoyed, with a time of access not much greater than is given by the short delay lines.

The ACE instructions specify the addresses—the locations in the store—of two numbers to be operated on, the operation, and the addresses of the desired destination of the result and the location of the next instruction. Thus four addresses are used, and all four accesses occur nearly simultaneously. In addition, multiplication and division occur in separate, autonomous devices, so that they can occur simultaneously with other operations.

The Spider Hunter

Mr. K. J. B. Wolfe, director of the fundamental research laboratory of the Triplex group of companies at 'Holly Grange', Balsall Common, near Coventry, believes that a member of his staff tackles one of the most unusual chores in the Midlands. He hunts spiders.

He is Mr. Raymond Saunders, who lives at Yardley, Birmingham, senior designer-mechanic at the laboratory, which concentrates on basic research on glass.

Sir Graham Cunningham, Triplex chairman and managing director, has commented that it is astonishing how little is even yet known about the basic behaviour of glass. It is the job of Mr. Saunders and his colleagues to find out.

To this end, much delicate apparatus is used, including a Babinet compensator, an intricate arrangement of lights and optical units which measures the amount of stress in toughened glass. For this apparatus there is required a scale with a dividing line of minute thickness. A human hair would be too thick by far.

Therefore, Mr. Saunders has become an expert on spiders. From time to time, he disappears into the 'Holly Grange' cellars in pursuit of these shy creatures. Old spider's webs will not do for his hairline measurement as they have too much dust adhering to them. Having found his spider, Mr. Saunders must persuade it to eject a brand-new web which he carries away at once in triumph to the laboratories above to incorporate into his next optical instrument.

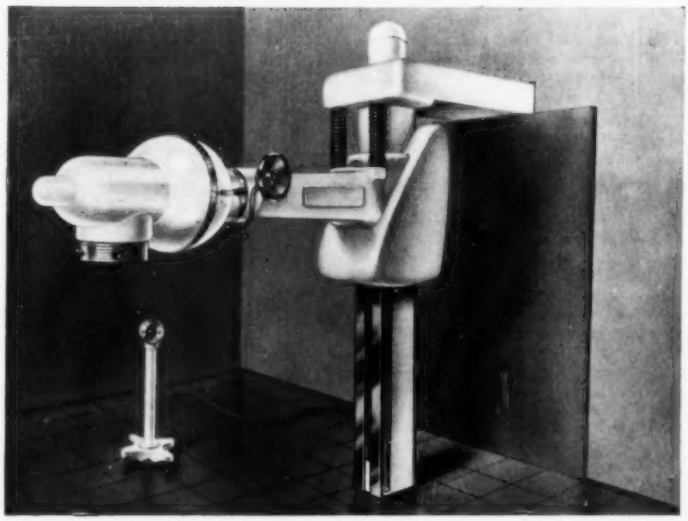
'I never thought I should end up as an arachnologist', says Mr. Saunders.

The spider's comments are not recorded.

A Laboratory of 1758

Just when was the word laboratory first used? Dr. John Rutty, M.D., an Englishman who became a society physician in Dublin, was an expert on the mineral waters, or spas of Ireland and their respective uses on the cure. He carried out many experiments on the virtues of the waters which we are told were tested in his *lavatorium*. The word laboratory is derived from the Latin referring to the place where one labours, so we see that Dr. Rutty two centuries ago laboured with his spa water experments in his wash up closet. The outcome of this medico's many experiments is reflected in his hydropathical works, such as 'An Essay Towards A Natural Experimental and Medicinal History of the Mineral Waters of Ireland'. So, the laboratory, the workshop of science, had a practical place in Irish medicine back in 1758.

LABORATORY EQUIPMENT & APPLIANCES



Above: **The stationary field Co.60. therapy unit.** *Below:* **The moving field Co.60. therapy unit.**

Radio-Cobalt Therapy Equipment

One of the more important steps forward in the peaceful uses of atomic energy was taken with the production, by nuclear reaction, of radioactive cobalt.

When this new and intense source of radiation was first made available for treatment and research, the Hunslet Organization, co-operated with the radiotherapy department of a Leeds teaching hospital in the design and construction of the necessary equipment.

Since then, there has been perfected a comprehensive range of radio cobalt units designed to serve the needs of moving and stationary field therapy and research with ease of control, speed and precision of operation combined with absolute safety under all conditions.

The cobalt therapy equipment described here is economical of space, highly efficient in the performance of the latest techniques and quickly adaptable to any exceptional need which may arise in the course of treatment research.

Stationary Field Co. 60. Therapy Unit
Comparatively simple in design, this efficient unit, designed solely for therapeutic use, allows for the setting up of all types of stationary field, given the universal movement of a standard couch. The head is provided with two movements: powered elevation/lowering, and hand operated angular turning of the diaphragm head. The head movement can be made between any limits to suit application.

The standard machine has a source housing which can accommodate British, Canadian or American sources. Also incorporated is a patent multi-leaf adjustable diaphragm, a valuable time saver when setting up.

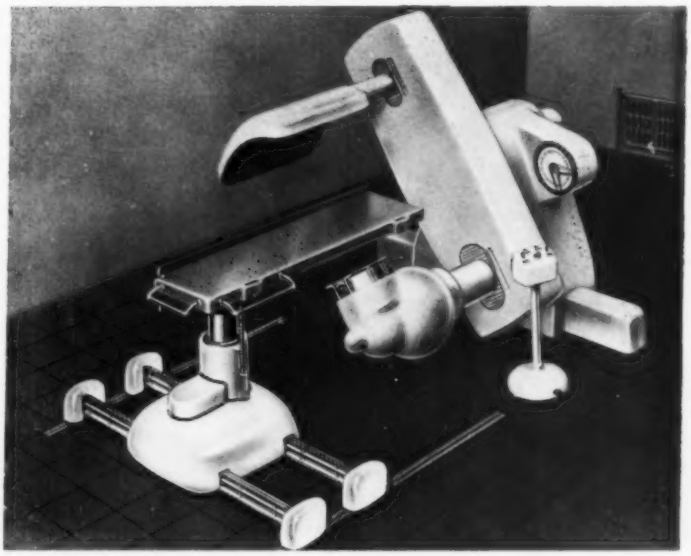
Moving Field Co. 60. Therapy Unit
This unit enables the fullest use to be made of all moving field techniques at present employed in therapy practice. It is also suitable for stationary field work, as the head having movement on its own axis, can also be elevated or lowered on the rotational carrying arm. Correct source to skin distance settings can therefore be easily obtained.

The speed of rotation is infinitely variable in the range 0·2 to 2·0 r.p.m. Arc therapy can be set, in steps of 10 degrees, up to a maximum of 360 degrees with automatic reversal.

This machine installation is equipped with a special treatment table having three movements, i.e. longitudinal and cross travel, also powered elevation and lowering actuated from the pedestal control column inside the treatment room.

A beam absorber is fitted on the carrying arm, opposite the isotope carrying head, to fully enclose the projected primary beam when the machine is used for treatment purposes. Should the treatment room walls give sufficient protection to the adjacent corridors or rooms, this absorber can be dispensed with.

(Manufacturers: Hunslet Precision Engineering Ltd., 125 Jack Lane, Leeds, 10.)



NEWS

General

The Mysteries of Glass

'After a year's intensive work in their new premises, the di ector, Mr. K. J. B. Wolfe, and his staff at the Triplex Fundamental Research Laboratory are beginning to see some very interesting things in the glass darkly.'

This was said by Mr. J. D. Anderson, works director of the principal Triplex safety-glass factory at King's Norton, Birmingham, welcoming guests to the first At Home Day at the laboratory on Friday, November 14. A considerable range of equipment, much of it built in the laboratory's own workshops and only recently installed, was shown carrying out research work.

Mr. Anderson recalled that when Sir Graham Cunningham, Triplex chairman and managing director, opened the building in December, 1957, he said that even then astonishingly little was known about the basic behaviour of glass.

'Rather more is known about glass today', declared Mr. Anderson. 'Mr. Wolfe and his colleagues know they are progressing; they know the road ahead is long but the journey is going to be very interesting indeed and the destination of benefit to the British motor manufacturing industry'.

Much had already been done to establish the basic fundamental knowledge underlying the various processes used to produce both laminated and toughened safety glass. Research carried out during the first exciting year at 'Holly Grange' had included work on the structure of glass and its variations under heat treatment; study of the glassy surface and its associated phenomena; study of stress in both normal and heat-treated glass with the associated general optical problems. Toughening of glass by chemical methods also had been investigated and investigations into the improvement of toughened safety glass by semi-conventional methods had begun.

Micro- and Semi-Microchemical Methods

Commencing January 10, 1959, a course of 12 lectures and appropriate practical work will be held on Saturday mornings at the Norwood Technical College, London, S.E.27, from 9.15 a.m. to 12.30 p.m.

This Course, which is particularly suitable for teachers, industrial and research chemists, is designed to survey the principal branches of chemistry in which small-scale methods have been successfully applied.

Lectures, illustrated by demonstrations, will deal with the following topics: Scope, aim and achievements of small-scale techniques; design and construction of simple apparatus; organic and inorganic preparations on the reduced scale; simple chemical microscopy and photomicrography; inorganic qualitative analysis; organic qualitative and quantitative analysis; physicochemical methods of analysis; chromatography; micro-techniques for the determination of molecular weight, etc.

In the main, apparatus either easily constructed or normally at hand will be used, as the Course is of an essentially practical nature.

Application forms for admittance to the course may be obtained from the Secretary of the College. The London fee for the Course is £1.

The Metropolitan-Vickers electron microscope, with ancillary equipment, installed in the new Triplex fundamental research laboratory.

Manufacturers' News

Guarantee for Balances

As from December 1, 1958, Stanton Instruments Ltd. are issuing a one year guarantee with all aperiodic, single pan, semi-micro and micro balances supplied in the United Kingdom. In addition, customers will receive one free service visit during this period which will ensure that the instruments are functioning correctly and are giving satisfactory service.

The scheme will be backed by the Stanton Service Organization which operates from centres in London, Southampton, Bristol, Birmingham, Leeds, and Edinburgh.

Pye Argon Chromatograph in the U.S.A.

After a successful tour in Western Germany, resulting in several large orders, the Pye Argon chromatograph is now being demonstrated throughout the U.S.A.

Mr. R. S. Evans, of W. G. Pye & Co. Ltd., in conjunction with their distributors, the Jarrell Ash Co., has planned a three month itinerary covering the larger industrial centres and Universities.

The Argon chromatograph has already been well received in several countries and numerous orders have been placed. It is anticipated that within the next three months several hundred Argon chromatographs will be installed in laboratories throughout the world.

Racal Expand

Racal Engineering Limited announce that, owing to continuing expansion, a separate division has been formed to deal with all matters relating to their range of instruments.

The new Instrument Division has its own development laboratories under the Chief Engineer, Mr. N. Elson, M.A., M.SC., A.M.I.E.E., and also includes a Special Products Section which will design, manufacture and install digital or non-digital instrumentation schemes for special applications.

A strengthened sales force and a separate Instrument Service Department has also been created to enable comprehensive sales and servicing facilities to be available quickly throughout the whole of the United Kingdom. A new feature is that an Applications Engineer is always on call to advise on the application of digital techniques to general industrial problems. This, coupled with the increased servicing facilities means that a closer contact will

Griffin GAS GENERATOR

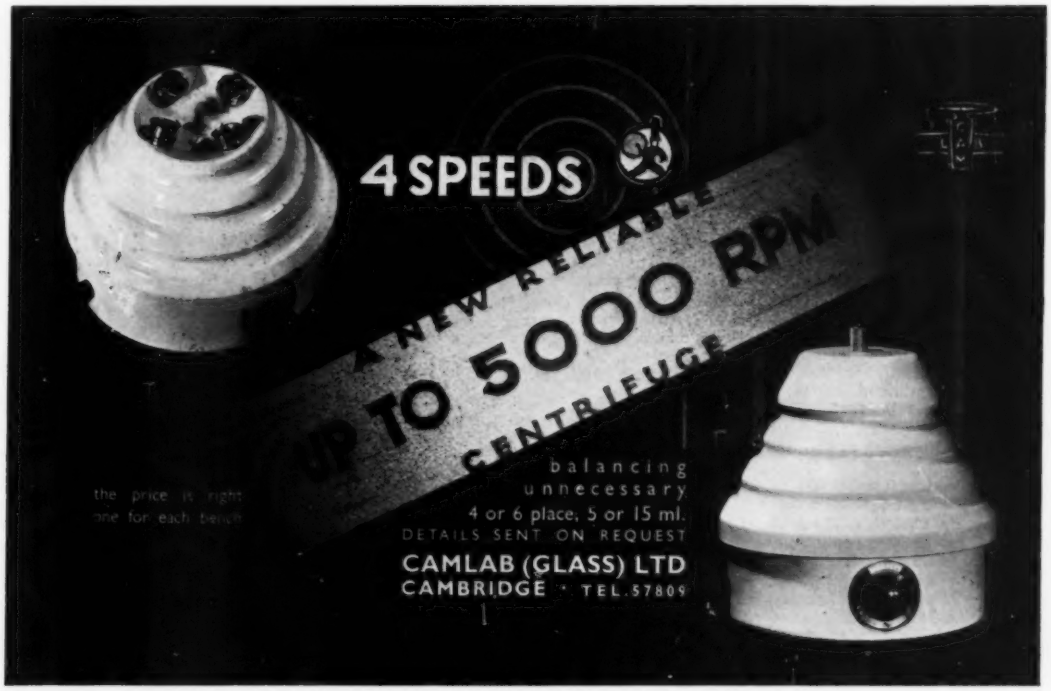
Based on the Kipp gas generator, this apparatus has many improvements. Fragility is avoided by using stoneware in place of glass; there are no ground stoppers or glass joints to seize. It consists of two main parts, of clean distinctive design and ample proportions for laboratory requirements. The outer container holds 7-8 litres of acid; the inner reagent chamber takes 5-7 lb. of ferrous sulphide or other reacting solid and lifts out for easy cleaning. *Please write for leaflet P2045.*

S28-030 ..... £8 5s. 0d.

GRIFFIN & GEORGE (SALES) LIMITED

Head Office: Ealing Road, Alperton, Wembley, Middlesex

Frederick St., Birmingham, 1 · Cheetham Hill Rd., Manchester, 4 · Renfrew St., Glasgow, C.2 · Johnston Terrace, Edinburgh, 1



be established with present and future industrial users of Racal instruments.

Sales Manager of the new Instrument Division is Mr. I. H. M. Campbell.

Change of Address

R. W. Jennings & Co., Laboratory Suppliers and Scientific Glassblowers, have now moved to 12-14 Stoney Street, Nottingham.

Publications

Polishing of Road Stones

The ever-increasing growth in traffic on the roads of Britain is creating new problems. One is the rapidity with which the stone in the road surface becomes polished.

Some roadstones show a much greater tendency to polish than others, and where they are used in the wearing surface of the carriageway a dangerously slippery condition often results when the road is wet. Skidding accidents due to this cause occur most frequently where the traffic intensity is high but in certain conditions as little as 3,500 tons per day has caused polishing in two years.

A simple laboratory test has been developed to distinguish between stones. The test is described in the new Road Research Technical Paper, No. 43, published for D.S.I.R. by H.M.S.O. (price 3s.).

Laboratory and full-scale road experiments extending over the past five years have shown that the test will help the highway engineer to select for his surfacings, roadstones which will have adequate skid resisting properties.

Fuel Research 1957

Following a careful examination of the present pattern of fuel research in Great Britain, the Fuel Research Board has recommended that only two main items of research should be transferred from the Fuel Research Station at Greenwich to the new Warren Spring Laboratory at Stevenage. These are the programmes of work concerned with the measurement and abatement of air pollution and with the synthesis of oil from carbon monoxide and hydrogen which are obtained from the gasification of coal.

This is contained in the Annual Report of the Fuel Research Board (published for D.S.I.R. by H.M.S.O., price 4s. 6d.) which explains how the state of fuel research has changed since the Station was established at Greenwich in 1917. At that time there was a need for the station to cover the whole field of research on solid, liquid and gaseous fuels. Since then, however, the pioneer work of the station has led to the growth of other organizations for research on fuels.

The new laboratory at Stevenage will be the centre of research in this country on air pollution. Work will be carried out on the reduction of pollution from furnaces or other appliances, on the chemical reactions of pollutants in the atmosphere, and on dispersal and convective processes in the atmosphere. The co-operative scheme for the measurement of pollution, together with the collection and analysis of the data, will also be continued.

Opportunities for Qualified Men

'More than ever before does the fate of nations and of businesses depend upon the qualified man. Decisions of moment are made on the advice which he gives, advice based on his specialized knowledge and his expert assessment.' So writes Sir Miles Thomas in his preface to the 1959 edition of the *Directory of Opportunities for Qualified Men* (Cornmarket Press Ltd., price 8s. 6d. net).

The purpose of this annual reference book is to provide men and women who have obtained professional or technical qualifications with a clear and extensive picture of the openings available during the coming year and to show the wealth of opportunity that exists for them.

The reference sections sects out in detail information about commercial and industrial organizations and government departments. The classified index summarizes in tabular form further information about the size of the organizations, whether men or women are employed, and the areas in which employment is offered. Another index refers men and women with particular qualifications to the organizations recruiting them.

The Directory also contains an extensive list of courses designed to give qualified men and women and executives a wider view of their own work or to keep them abreast of events in allied industries.

MEETINGS FOR THE MONTH

Mid-January to Mid-February

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

January 7

The Society of Instrument Technology (South Yorkshire Section). At The University, St. George's Square, Sheffield, 1. 7 p.m. 'Instruments for Flame Radiation and Heat Transfer Measurements', by Prof. M. W. Thring.

January 13

The Society for Analytical Chemistry (Midlands Section). At The University, Birmingham, 3. 6.30 p.m. 'The Analytical Chemistry of Cobalt and Nickel', discussion to be opened by A. J. Brookes.

January 14

The Physical Society (Colour Group). 'Colour and Glass', by H. Cole.

The Society of Instrument Technology (London Section). At Manson House, Portland Place, London, W.1. 5.30 p.m. Symposium on Storage Media.

January 16

The Society of Instrument Technology (Cheltenham Section). At the Rotunda, Cheltenham. 7.30 p.m. 'The Microscope in Engineering', by A. E. Bingham, M.I.Mech.E., F.R.Ae.S.

January 21

The Society of Instrument Technology (Newcastle Section). At King's College, Stephenson Buildings, Newcastle-on-Tyne. 7 p.m. 'Applications of High Speed Strain Recording Equipment', by R. Kasler.

The Society of Instrument Technology (South Wales). The Physics Lecture Theatre of the Welsh College of Advanced Technology, Cardiff. 6.45 p.m. 'Data Logging', by C. H. Copley, B.Sc.

January 27

The Society of Instrument Technology (London Section). At Manson House, Portland Place, London, W.1. 5.30 p.m. Symposium on Flow Measurement.

January 30

The Society for Analytical Chemistry (Scottish Section). At James Craig Restaurant, 10 Woodlands Road, Glasgow, C.3. 1.30 p.m. Annual General Meeting.

January 31

The Society for Analytical Chemistry (North of England Section). At the Engineers' Club, Albert Square, Manchester. 2.15 p.m. Annual General Meeting, followed by an Ordinary Meeting on 'Synthetic Foodstuff Colours —Control of Quality', by H. E. Stagg, B.Sc., F.R.I.C.

February 4

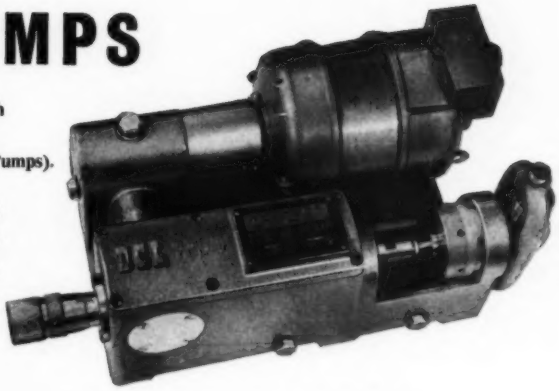
The Society for Analytical Chemistry. At the Meeting Room of the Chemical Society, Burlington House, London, W.1 7 p.m. Meeting on 'The Estimation of Pesticide Residues'.

February 6

The Society of Instrument Technology (Fawley Section). At Copthorne House, Fawley, Hants. 'Laboratory and Industrial pH Measurement and Titrations', by G. Mattock, B.Sc., Ph.D., A.R.I.C.

METERING PUMPS

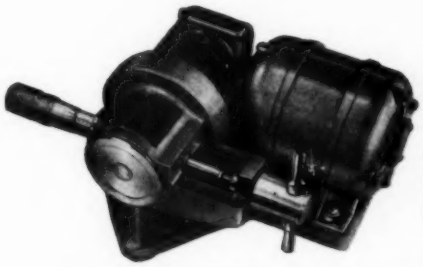
Laboratory Equipment Tests have been carried out on both these pumps and reports were published in 'Laboratory Practice', April 1957 (Micro Pumps) and July 1958 ('M' Pumps).



'M' PUMPS

Accurate metering pumps suitable for most liquids; flow variations obtainable by micrometer adjustment of stroke. 10 capacity ranges from 0—0.75 litres/hr. to 0—37 litres/hr.

Delivery Ex Stock



MICRO PUMPS

For small constant flow adjustable by micrometer control of pump plunger stroke. 9 capacity ranges from 0—7 cc/hr. to 0—1500 cc/hr.

Pump heads of different capacities are readily interchangeable.

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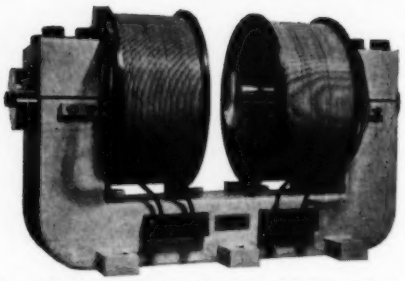

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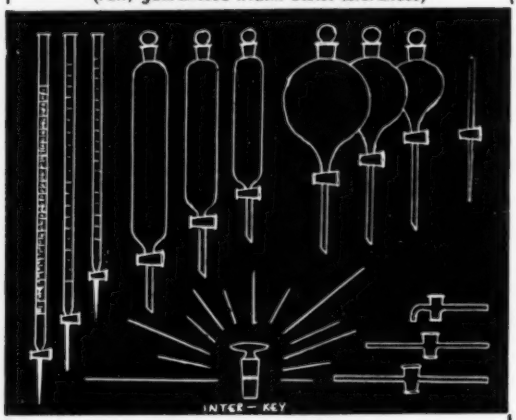

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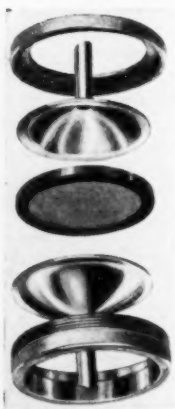

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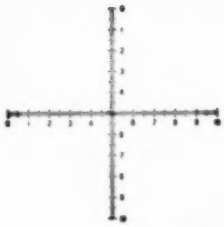

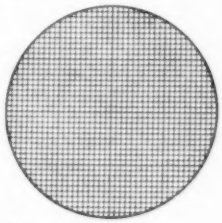

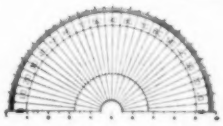

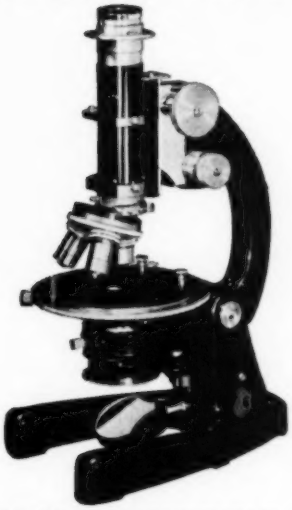

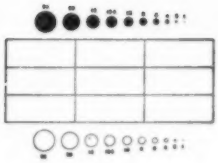

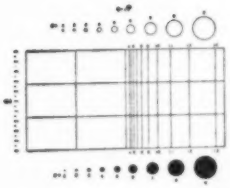

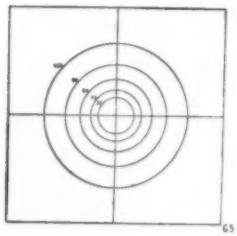

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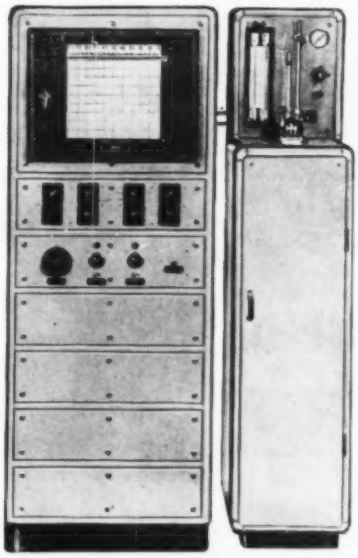

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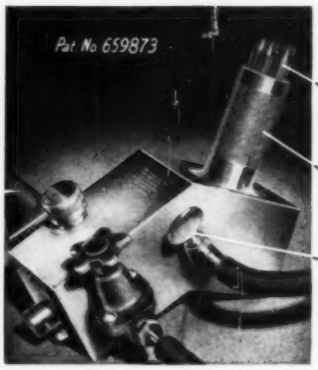

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